DOCUMENT RESUME

ED 327 375 SE 051 819

TITLE National Energy Education Development (NEED) Resources Local Participation Kit.
INSTITUTION National Energy Education Development Project, Reston, VA.
PUB DATE 89
NOTE 167p.
AVAILABLE FROM National Energy Education Development Project, 1920 Association Drive, Suite 514, Reston, VA 22091 ($25.00).
PUB TYPE Guides - Classroom Use - Guides (For Teachers) (052) -- Guides - Classroom Use - Materials (For Learner) (051)

EDRS PRICE MF01/PC07 Plus Postage.
DESCRIPTORS Alternative Energy Sources; *Cooperative Learning; *Elementary School Science; Elementary Secondary Education; *Energy Education; *Environmental Education; Fuels; Instructional Materials; Program Descriptions; *Science Activities; Science Education; Scientific Literacy; *Secondary School Science; Teaching Methods

ABSTRACT

National Energy Education Development (NEED) is concerned with the dissemination of energy education information, the way children learn best, and the type of citizens students will become. Cooperative learning, where students take responsibility for their own learning and that of others in their group, class, school, and their community, is emphasized. Included in this packet of materials are student project activities, games and icebreakers (such as the Energy Enigma game), plays using "energy tales," the NEED Youth Awards Program for Energy Achievement, rock performance, the 1991 NEED Energy Education Poll, fact sheets on energy, and The Great Energy Debate Game. (KR)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
Jorge Chacon
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)
☑ This document has been reproduced as received from the person or organization originating it.
☐ Minor changes have been made to improve reproduction quality.
• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

ED327375

SE 051 819

National Energy Education Development Project

PROJECT ACTIVITIES

CONTENTS

Energy Resource Center 2
Promoting Energy Lessons 2
Energy Placemats 3
The Energy Times 4
Adopt A Class 5
Energy Time Capsule 6
Energize Your Local D.J. 8
Energy Past And Present 10
Energy Tip Hotline 10
The Senate Energy Hearings 11

ENERGY RESOURCE CENTER

GOAL

To establish an energy information resource center for books, magazine articles, pamphlets, and other related materials.

BACKGROUND

One of the best services a school's NEED committee can offer teachers and students is a comprehensive energy education resource center which can support NEED programs and activities in your school or community for years to come.

HOW TO ORGANIZE

STEP 1 Check to see if your school library already has a collection of energy education materials. If it does, work with the librarian to review these materials to determine whether they are current and whether the collection is comprehensive, i.e., do the materials cover most energy issues and viewpoints?

Determine what energy education materials are available in your community libraries and find out how to check out materials from all the libraries.

STEP 2 Begin collecting additional resources. Take advantage of materials available from state and local agencies, utility companies, and energy-related businesses in your area. You can find these organizations in the telephone book.

For more up-to-date materials consult the Readers' Guide to Periodical Literature, a magazine index which – depending on your library – may be on microfiche. When you find energy-related articles, make a copy of them for your resource center. Don't overlook audio-visual resources like movies and filmstrips.

STEP 3 People who are knowledgeable about energy may prove to be the most important resource for any NEED project. Keep a list of people in your area – congressmen, university professors, business people, shop-owners, parents, teachers – who are experts in some field of energy or energy conservation and who are willing to help your NEED committee in energy-related activities.

STEP 4 Once you have collected your brochures, articles, and other materials, organize them into files by topic, such as acid rain, conservation, oil prices, energy experts, etc. Categorize the materials by topic, grade level, and discipline. The final list should also say where the materials can be found, i.e., your resource center, school or local library. Update your resource center on a regular basis. It should be updated at least once a year. Distribute a revised resource listing as necessary.

STEP 5 Tell the faculty and participating students about the energy education resource center. You can do this during a faculty meeting or over your school's public address system. Be available to give assistance as needed.

PROMOTING ENERGY LESSONS

GOAL

To prompt all teachers to teach at least one energy-enriched lesson during NEED Week.

BACKGROUND

This activity is designed to involve all the teachers at your school, no matter what their discipline, in NEED. Your job will be to encourage teachers to teach an energy lesson and to collect energy education materials for teachers to use.

HOW TO ORGANIZE

STEP 1 The first thing you need to do is obtain permission from your principal to conduct this activity. Set up a meeting with your principal to discuss your plan of action. You'll need to give him or her a written plan at this time too. The following steps will give you some ideas on developing a plan.

STEP 2 Start locating energy education materials and resources for teachers to use. If your school has an energy education resource center, start there. If it doesn't, you can write or call local utility companies and your state energy office for assistance. Just be sure to give yourself plenty of time to get the materials together.

Printed on recycled paper

Once you've collected some energy materials, review the materials and sort them into subjects (English, science, home economics, etc.) and grade levels. If you discover that educational materials for some subjects or grade levels are hard to find, work with the teacher to develop an appropriate lesson plan or help him or her line up a guest speaker.

STEP 3 Encourage teachers to present an energy lesson during NEED Week. Several promotional ideas are listed below.

- Design posters promoting energy-enriched lessons and put them in the teachers' lounge or work rooms.
- Place a memo in teachers' mailboxes explaining NEED Week and asking teachers to participate in NEED by teaching energy lessons.
- Make a presentation at a faculty meeting about NEED Week and about the materials you have ready for teachers to use. Be creative in your presentation. For example, present a scene from the NEED '91 play or an Energy Rock Performance.
- Speak enthusiastically to teachers on an individual basis about your program.
- Offer incentives for teachers. Give away coupons for free car washes or lunches, or ask local merchants to offer special discounts for participating teachers at their stores.
- Give teachers a NEED button, T-shirt, or other item as a reward for teaching energy lessons. Create a Certificate of Appreciation or "I'm a Teacher in NEED" button for participating teachers.
- Hold a special luncheon for teachers who participate.

STEP 4 After the NEED celebration, evaluate your program to see if your goals were met. Talk to teachers one-on-one, or pass out a simple evaluation form for each to complete.

ENERGY PLACEMATS

GOAL

To create energy education placemats for area restaurants to use during NEED Week and/or on NEEDay, or anytime.

BACKGROUND

In this activity, you'll be designing a placemat to educate your community about energy and about NEED. Making energy placemats is a creative and educational activity for all students. However, this activity takes some advance planning. Restaurant managers will want to see a sample of your NEED placemats before making a commitment to use them, so be prepared to have your students go to the drawing board about two months prior to NEEDay.

HOW TO ORGANIZE

STEP 1 Decide what you want people to learn about energy from your placemat. Some things you might consider are:

1. Which energy sources are renewable and non-renewable.
2. What five major sources of energy are used today to generate electricity in the United States.
3. Four ways to save energy at home.
4. Three historical facts about energy.

STEP 2 Now you are ready to design your placemat. To make the placemat fun and informative, choose a variety of activities such as crossword puzzles, jumbles, find-a-words, graphs, and trivia (Energy's Believe-It-Or-Not). When designing your placemat, keep in mind that it should be attractive and informative. Leave space on your placemat to acknowledge a restaurant's or printer's sponsorship.

STEP 3 Get an estimate on how much it will cost to print your placemats so you'll know how much to charge the restaurants that use them. It's a good idea to speak to several printers to get the best price. You may find a printer to donate the cost of the printing in return for acknowledging the printer's sponsorship on the placemat.

STEP 4 Contact the restaurant managers in person and explain to them what NEED and NEEDay is all about. Show them your sample placemat and give them an estimate on how much the placemats will cost. Be prepared to leave a sample and a written proposal outlining your expectations, including the date you need an answer by.

STEP 5 As the deadline nears make a reminder call. Once your orders are in, get everything ready for the printer. Make sure your directions are clear so that there will be no mistakes. When the placemats are ready deliver them to the restaurants several days before NEED Week or NEEDay if possible. You might also like to visit the restaurant on NEEDay to photograph the placemats in use.

THE ENERGY TIMES

GOAL

To publish an energy newspaper for distribution to students and the community during NEED Week.

BACKGROUND

An energy newspaper can serve many purposes. It can preview upcoming events and prime students and adults for NEED, or it can review the year's NEED celebration in a special single issue. Producing an energy paper will also be a good way to sharpen your research and writing skills while learning about energy at the same time.

Another option is to involve your regular school newspaper in your efforts. Talk to the school editor about including an energy/NEED column in each issue or doing a one-page spread or pull-out section on NEED during NEED Week. The steps outlined below will help you undertake a cooperative effort with your school newspaper.

HOW TO ORGANIZE

NOTE: If you are planning to promote NEED and any energy education activities your school has organized for NEED Week, you should be ready to distribute your newspaper at least five to ten days before NEED Week. This means you should begin working on your paper or special columns, etc., by early January. This will give you enough time to produce a newspaper or a special supplement, that you will be proud of.

STEP 1 Brainstorm articles you would like to include. For example, articles previewing upcoming NEED Week activities such as Great Energy Rock Performances or the NEED '91 play, *The Incredible Energy Tales*. The idea is to pique student interest in NEEDay and NEED Week events.

Here is a list of article and feature ideas to help you get started:

- an article by two people who are on opposite sides of a controversial energy issue, a point/counterpoint feature.
- a story on teaching an energy education unit or lesson.
- an article discussing the results of the NEED '91 Energy Education Poll or the results of your own survey.
- an interview with elderly people on how energy affected their lives when they were your age, i.e., cars, air conditioning, refrigerators.
- an article about a new (fission, photovoltaics) or an old (wind, coal) way of producing energy.
- a story about how much energy the school uses.
- a helpful hints column on saving energy.
- games, crossword puzzles, or energy jumbles.
- energy horoscopes, i.e., Pisces – Your car will continue to guzzle gas if you keep on idling.
- an article about a family producing or saving energy in a unique or effective way.
- profile of an energy economist, engineer, historian, or of a student preparing for an energy career.

NOTE: Steps 2, 3, 4, and 5 are applicable if you are producing a newspaper/newsletter independent of the regular school newspaper. If you are working with the regular newspaper staff on a special column, insert, or independent issue follow their procedures.

STEP 2 Decide who your audience will be. Will you limit distribution to students and teachers in your school, or will you distribute it to the community as well?

Next, decide how you will distribute your newspaper. If you're going to distribute it only at your school, you can distribute it in a class that all students attend, English classes for example. If you're going to distribute your paper throughout your community, you can distribute it through the local library, grocery stores (clerks could put a copy in customers' grocery bags), newsstands, or newspaper carriers.

STEP 3 Determine how much it will cost to publish your energy newspaper. Here are some items you should consider when developing a budget.

- How many newspapers will be needed?
- Will the newspaper be produced on a copying machine or by a local printer?
- Will the newspaper be printed in one or more colors?
- Will the newspaper contain photographs? (Consider film, developing, and printing expenses.)
- What color and quality stock paper will be used?
- What supplies will be required to prepare the newspaper to go to press?

STEP 4 Establish a plan for obtaining the money or services to publish your newspaper. There are several options you may choose, or you may choose more than one method. Whatever plan you choose, make sure you get permission from your teacher or principal before you proceed.

The first option is to speak with your principal or teacher advisor. Ask if your committee could make use of special discretionary funds that might have been set aside for such an endeavor. If not, then consider the following suggestions.

Contact a local company or business about sponsoring your newsletter entirely. Approach the owner or manager of a business that has an interest in energy or a history of supporting worthwhile educational activities. Once you've developed a good outline of the contents of your newspaper and a budget, meet with this person(s) to further explain the items on your outline. Leave with this person a written letter covering the same points you discussed in your meeting and a copy of your budget. It's also very important to tell potential sponsors that acknowledgement of their sponsorship will have a prominent spot in your newspaper.

You might also ask a company if it would print your newspaper in its shop or by its printer, and still provide funds for the other expenses related to producing a newspaper.

Another option is to sell advertising space. You can ask advertisers to offer discounts to patrons who bring an ad or coupon in with them, i.e., discounts on a tune-up or oil change, coupons for energy-efficient appliances. (These discount coupons might also encourage students to take the newsletter home to their parents, making it more worthwhile for businesses to buy advertising space in your paper.)

Still another option is to obtain several sponsors. It will be easier to raise the funds to produce your newspaper if the cost is divided among several sponsors.

STEP 5 Writing and producing your newspaper is the next order of business. You'll need to assign certain students to write stories and others to produce the newspaper. A description of these responsibilities is given below.

Reporters

Once you have decided on the stories you would like to cover, assign a reporter. Your journalism teacher may offer some good points on writing a news story.

Production Committee

Decide on the format for your newspaper. How many pages will it be? How many columns per page? What will you call the newspaper? What will you use for a masthead? If you want to add graphics to your newspaper, have a talented student do some pen and ink drawings or cut out art from NEED publications. If you use art from other publications, make sure there is no copyright infringement.

Once the articles are typed up in the proper column width, the newsletter can be pasted up. Consult you school's journalism department or art department if you need help in this area.

TIPS

1. Put "punch" and enthusiasm in your writing.
2. Keep your newsletter simple in design and scope.
3. Use an organized and attractive layout style to capture the reader's attention.
4. Use artwork sparingly and with purpose.
5. Avoid handwritten newsletters – always have them typed.
6. Use colored paper if your budget will allow it.
7. Keep the stories concise and the paragraphs short for easier reading.
8. Always proofread your work carefully. Do not allow typographical errors to mar your publication. Have at least two people proofread.

ADOPT A CLASS

GOAL

To prepare and present an energy lesson to a group of students during NEED Week.

BACKGROUND

For this activity, a group of students "adopts" a class, develops an energy lesson, teaches the lesson, and then evaluates the lesson to see how well it communicated the energy information to the adopted class.

HOW TO ORGANIZE

STEP 1 Decide what grade level you want to teach. Choose a lower grade or a class at the same or higher grade level than yourselves. Don't feel that you have to teach your NEED lesson to a science class. Be creative, try teaching an energy lesson to a French, math, or other class.

STEP 2 Decide exactly what you want your adopted class to learn from your energy lesson. Some sample lesson objectives are given below.

Sample Lesson Objectives (choose one or two).

Upon completion of the energy lesson, the students will be able to list:

- which energy sources are renewable and non-renewable.
- the five major sources of energy used to generate the nation's electricity.
- the major ways of saving energy on the road (or home).
- four historical facts about the use of energy.

You may choose one or two of the above objectives for your lesson or develop your own. Be realistic; you can't achieve four or five objectives in one lesson, especially with very young children.

STEP 3 Discuss ways to communicate your lesson to your adopted class. Remember younger students generally have shorter attention spans than older students. Come up with your own lessons or use one of our activities or games.

One method of teaching young children about energy is to do a puppet show. Other ideas include developing an energy game show or performing a scene from the NEED play, or playing an energy game.

Another possibility is to hold a Spelling "E." A Spelling E is similar to a regular spelling bee except that all the words deal with energy. To organize a Spelling E, develop a list of energy words and then place them in categories according to spelling difficulty. Use the easier words first in your Spelling E and the more difficult ones later.

You may also develop a more traditional lesson plan that uses handouts or an overhead projector. Another good source for lesson plans is the NEED Activities guide. Ask your teacher about this guide if you don't already have it.

Research the topic or topics you will be teaching so that you know the information extremely well. Reviewing energy education materials, viewing videotapes, and hearing speakers discuss a topic are all good ways to become knowledgeable about your subject.

Remember, you must understand your topic thoroughly before you can teach others about it.

ENERGY TIME CAPSULE

GOAL

To prepare an energy time capsule which shows the role of energy in today's world and its predicted role in the year 1995 or beyond.

BACKGROUND

This activity gets you and your community to look at the future of energy in the United States. Your mission will be to collect energy-related items for burial in a time capsule. The items you collect will relate the role of energy in today's world and predict its role in the future. A formal burial ceremony will be the grand conclusion to this informative and fun activity.

HOW TO ORGANIZE

STEP 1 Set a target date, perhaps National Energy Education Day, for the burial of your time capsule and accompanying ceremony. You will need to get permission for the ceremony as well as a location for the burial of your time capsule from your school principal early in the planning stages for this activity.

STEP 2 Gather your resources and begin your research. You can use your own energy education materials, or you can use materials from a library, the Department of Energy, or Congressional testimony.

Interview local energy experts from business, government, or universities. Arrange for a speaker to address your group during your preparation period or invite several speakers from different fields to make a panel presentation to your group or the entire school. Ask the energy experts what their opinions and predictions are for the year 1995, or whatever year you have chosen to unearth your capsule.

Here are some general topic areas you might consider:

1. the price of a barrel of oil, a gallon of gasoline, the cost of a kilowatt-hour of electricity, or the cost of a thousand cubic feet of natural gas...today and in the future;
2. the best, worst, and average MPG rating for new cars today and in the future, types of fuels used today and fuels of the future;
3. the top nine sources of energy and their present and projected usage, the per capita energy use of the average American;
4. foreign petroleum imports, domestic production, offshore drilling, political and economic implications (present situations and in the future);

5. energy efficiency in today's homes (appliances, heating systems, etc.);

6. air pollution levels, today and future predictions, environmental issues;

7. waste management, recycling, modern landfills, (present and in the future);

8. nuclear energy, number of existing plants, current and projected, nuclear waste disposal issues, sites, etc.;

9. energy usage by each of the four sectors of today's economy – today and projected.

STEP 3 Once you've completed your research, start preparing the items that you want to put in your time capsule. Brainstorm a list of 40 or more items. Then reduce your list to 20 items and begin working on these. The five descriptions below will give you a better idea of what you can prepare for your time capsule. Remember, they all have to fit into your capsule!

SUGGESTED ITEMS FOR TIME CAPSULE

- Make a pie or bar graph that shows how much energy each major source of energy currently supplies the United States. Make a similar graph for the year 1995 (or year of your choice). The 1995 graph may differ in size depending on the amount of energy the U.S. is expected to be using at that time. The size of the sections of the graph may also differ as different energy sources may become larger or smaller suppliers of energy in 1995. In each section of the graph, include the percent of total U.S. supply and the amount of energy in quads or the appropriate unit for that energy source.

- Create a poster that shows two barrels of oil drawn to scale. Under the first barrel write 1990 and under the second write 1995. Shade the barrels to show how much oil is supplied by domestic production and how much by imports. In the import section for the barrels, you could write in the names and amount of oil supplied by the top five sources of foreign oil. In the domestic portion of the barrels, you could use two shades, one representing offshore production, the other onshore.

- Obtain Energy Efficient Rating (EER) labels for several commonly purchased home appliances like hot water heaters, refrigerators, washers, and dryers. Make two copies of the labels for each appliance. Keep one label as it is, but on the other cross out the 1990 (or 1989) figures and replace them with your own predictions. You can do the same with the MPG ratings found on the window stickers on new cars or from car advertisements in magazines.

- Tape interviews with energy experts, asking them for their energy predictions for the year 1995.

- Try to think of other items that you can include in your time capsule that will tell those who unearth it in the future a little about today's energy production and use. For example, if electricity in your area now costs eight cents a kilowatt-hour, you might put eight cents in an envelope, or you might put in the amount you think a kilowatt-hour of electricity will cost in 1995. You could also include copies of electric bills, photographs of gasoline pumps or signs showing the price of gasoline, sales brochures for appliances, etc.

STEP 4 Obtain a small, waterproof container to use as your time capsule. Ask local businesses, industrial arts classes, or a sheet metal firm to donate a capsule.

STEP 5 Arrange an official burial ceremony for your time capsule. Prepare a ceremony agenda and send invitations to local officials, guest speakers, school officials, students, newspapers, and radio and television stations. Also, select one student at this time to act as the host.

Invite your guests to arrive early to view the items that will be sealed in your capsule. For a really festive touch, serve your guests refreshments during this time too.

At the beginning of the actual ceremony, have the student host introduce your burial project. Ask a guest speaker to address the audience at this time. Then have students place the items into the capsule, each giving a 10-15 second speech about their item. Just before the capsule is lowered into the ground, the host can give a short speech that summarizes your energy predictions.

STEP 6 Record the burial in the school records. Include a documentation file with photographs of the event, a list of the items enclosed in the capsule, the names of the student participants, a location map of the capsule, notes from the interviews and speeches, and any publicity clippings. Add a reminder for the unearthing ceremonies and assign specific class members to follow through on that aspect of the project (an excellent event for a 5 or 10-year reunion), or assign first- or second-graders to unearth the capsule when they are high school seniors.

NOTE: A great resource to help you with your research is the U.S. Department of Energy's Annual Outlook with Projections to 2010. Your school librarian can order this booklet for free! Just ask him or her to write to the following address:

National Energy Information Center
EI-20 Energy Information
Administration Forrestal Building Room 1F-048
Washington, DC 20585
(202) 586-8800

ENERGIZING YOUR LOCAL D.J.

GOALS

To have students learn the basics of media contact as well as gain an understanding of the workings of their local radio station.

To research and learn about at least one energy topic.

To broadcast energy information to the public.

BACKGROUND

Energizing Your Local D.J. can be used as a full class activity or a small group activity. If the full class participates, divide the students into groups of three to four. Each group will then have a different topic for research and writing.

It is best if the students themselves approach the radio station about the activity. The station should be notified at least a month in advance; six weeks is preferable. At a minimum, most stations will agree to carry the public service announcements, and possibly use some of the stings and teasers. The chance that a station will use the students' material is increased if the activity is timed near NEED Week in March, Earth Day's anniversary, or other calendar events. Ideally, you would like to have the station decide to use your material over a whole week. For example, if the entire class is divided into five groups, the station could use one group's topic a day. Find out how flexible the station can be.

HOW TO ORGANIZE

STEP 1 Everyone in the group should read and discuss the Group Contract sheet (available in the NEED Activities Guide). Then, the group should come together and build its own group contract. After the contract is completed, it should be signed by all.

*** Turn in a copy of the group contract with signatures to your teacher.

STEP 2 Choose a topic on which to focus. One suggested topic, Aluminum Recycling, will be used throughout these directions as an example of the various options available. Other suggested topics are conservation in the home, conservation on the road, plastic recycling, waste management, and auto maintenance.

The emphasis of this activity is on reaching and educating the public. Therefore, try to choose a topic that the average person can relate to and do something about. Aluminum recycling is a good topic because it affects nearly everyone, and everyone can do something simple to help. No matter which topic you choose, make sure that a large audience can relate to and use its information.

STEP 3 Research your topic. There are several sources for research available:

1. *Energy Exchange* magazine. Ask your teacher for back issues of NEED's magazine. Every issue contains informational articles on a variety of energy topics.

2. Local experts. There may be people in your community who can give you information. For example, if your topic is conservation in the home, your local utility company usually has pamphlets or other materials that can help. Check local recycling centers for information on recycling. Also, check your Yellow Pages.

3. Local or school libraries. Basic reference materials such as encyclopedias are a good background source as well as specific books and pamphlets on the topics you are researching.

4. The Reader's Guide to Periodical Literature. This guide will help you find recent magazine articles on your topic and current information and interesting stastistics that might help people visualize your topic and motivate them to help.

   For example, in the Aluminum Recycling unit, some examples of interesting statistics would be: Each recycled aluminum can saves the equivalent of one cup of gasoline; or Americans recycled $900 million worth of aluminum cans in 1989; or every year Americans throw away enough aluminum to rebuild the entire American Airlines air fleet 71 times.

   *** You will need approximately 15 to 20 statistics/facts. Write all these down and make copies for everyone in the group. Hand a copy in to your teacher as well.

STEP 4 Put your information into a form that will work well on radio. Below are some basic suggestions, but take some time to talk about other ways in which your information can be used.

1. "Stings" and "Teasers." These are short, one sentence, "Did you know" messages. Use some of your most shocking/interesting facts here. For example, "Did you know that every recycled aluminum can saves enough energy to burn a 100 watt light bulb for 3.5 hours.? Over the course of a year, this saves 120 kilowatt-hours of electricity or 100 pounds of coal." The radio station can use these in many ways – just before a station break, in between commercials, or even worked into the D.J.'s normal patter.

2. Public Service Announcements. These "PSA"s are simple short messages about how people can help.

These should be fully written out, and may vary in length, such as 30 seconds, 45 seconds, and 60 seconds. These can involve many facts, or one or two important ones. The radio station will use these mixed in with its normal commercials. Following is an example PSA for the Aluminum Recycling unit.

Sixty Seconds PSA for Aluminum Recycling

Would you ever throw away six cups of gasoline without thinking about it? That is what you do every time you throw away a six-pack of aluminum cans.

Hello. My name is _____, and I would like to talk to you about something that you can do to help save our environment. I'm talking about recycling aluminum. It's easy, it's free, and it helps our country, our environment, and our planet. You see, recycling an aluminum can saves 95 percent of the energy necessary to make a new can. In other words, recycling a can saves the equivalent of a cup of gasoline every time it is recycled – and aluminum is always recyclable.

So please help conserve energy. Already 61 out of every 100 aluminum cans are recycled – but it could be more. The next time you go to throw away a can, stop and think.

Thank you. This has been a public service announcement of (station call letters).

OPTIONAL: It may be possible for you to get local celebrities to do these PSAs for you. If you have a local celebrity, approach him/her about helping you. Most celebrities do PSAs all the time, and will be willing to help.

3. Trivia Contests. Most radio stations run trivia contests all the time about various subjects. All you need to do is phrase some of the more interesting facts as trivia questions. For example, "What common recyclable metal was considered more precious than gold 150 years ago?" Answer: "Aluminum". You may wish to contact local businesses about providing prizes for these trivia contests.

4. Call-in Talk Show ideas. If your local station has a call-in show or a talk show, one of your controversies may be a good topic. For example, "Should (your state) pass (or repeal) an aluminum can deposit bill?" is a good question that can adapt to either a call-in or talk show format. Ask the station whether they have a show that can use these ideas.

5. Any other ideas that your group can brainstorm.

*** Turn in a list of the group's best ideas to the teacher.

STEP 5 You may want to ask the station for a guest D.J. hour. One person from the group might be able to get some time – 15 minutes, 30 minutes, possibly even an hour – to actually be the D.J. for the station. The student D.J. needs to be someone with a clear speaking voice and other good radio mannerisms. Above all, they should not be too nervous about the job.

STEP 6 Program the D.J.'s time slot.

Music. There are probably songs that can relate in some way to the topic you are discussing. For example, if your topic is about renewable energy, you can use "Here Comes the Sun." Remember, any songs you choose must be cleared by the station's Program Director. Of course, your group could write and produce its own music. This is especially recommended for topics like aluminum recycling where there is not likely to be much music available. See the activity "Great Energy Rock Performances" for more ideas and details.

PSAs. You should have these written already. There should be no more than one PSA every ten minutes of air time, and this may still be too often. Don't overdo the PSAs.

Stings and Teasers. Once again, these should already be written. Do not overdo these either.

Talk show or call-in shows. This is probably one of the better uses of your radio time. You can simply declare the phone lines open, and take listeners' calls at any time; or, you can set aside a block of time to have people call in. Remember, however, that you cannot count on people to call in, so have other material planned for a block of call-in time if no one calls. It is also possible to plan for a guest on a talk show – you can use a local expert who helped you with information during your research, or anyone else who would be willing and interested.

Other. The radio station may require that you run a certain number of station identifications, or perhaps even advertising during the show.

*** It is not necessary to script the show word for word, but a minute by minute script will be very helpful. After the group is finished with the script, hand it in to the teacher. The script will also need to be given to the station's Program Director.

STEP 7 Final preparations of the material need to be completed. All the stings and teasers should be neatly typed and understandable. The PSAs must be recorded or ready to be recorded. Anything else that the radio station needs should be given to them in a neat and legible form.

*** Hand in all your materials to your teacher.

STEP 8 Now that your radio station is ready to support you, it's time to support your radio station. Make sure that everyone in the community is aware that the radio station will be carrying your material. This can be done in several ways. Ask your principal to make an announcement to the entire school. Have all the students at your school tell their parents, brothers and sisters, and other friends. If your group supports the radio station, they will be more likely to do this in the future. Make sure that everyone you can get in touch with knows about the station's effort. You may want to write the station a thank-you note from the group or class.

ENERGY PAST AND PRESENT

GOALS

To publish a creative and personal energy publication for distribution during NEED Week.

To involve older members of the community in energy education and to develop a dialogue between today's generation and those of yesteryear.

BACKGROUND

This activity is a spin-off of the ever popular *Foxfire* books. The activity is appropriate for grade levels 5 -12 and would fit in well with a social studies, English or creative writing curriculum. The end result can be a sophisticated published booklet, a school generated xeroxed booklet, or a series of articles in the school and community newspapers.

HOW TO ORGANIZE

STEP 1 Brainstorm a list of energy uses – examples include transportation, farming, cooking, leisure, etc. – in a large group setting.

STEP 2 Divide students into small groups of three to five. Each group chooses or may be assigned one area to study.

STEP 3 Students research how energy is used TODAY in their particular area of study. Allow several days for research depending on class time and availability of materials.

STEP 4 This step involves interviewing older members of the community to discover how energy was used when those members were young. Suggestions:

1. Each group should be responsible for five to ten questions that can be asked of their guests. For example: How was your home heated when you were a child? Where did the fuel come from? How were you involved in getting the source to your home? In the case of wood as a source of fuel, how much time was devoted to supplying this energy source. What was the heating system like? How effective was it?

2. Invite older community members in to speak to the class as a whole with each group asking specific questions. Invite grandparents, aunts, uncles, or call a local "old folks" home. If they can't travel to school, have small groups travel out. Or, interview individually one to one. Take good notes and/or tape the interview to listen to later.

STEP 5 Review notes and write a straight-forward news article comparing the energy use today with its use in years past. Or, write short stories, skits/plays comparing today's and yesterday's use.

STEP 6 Compile results in a booklet. Design an eye catching cover and think about using photos. If time and budget allow, contact a printer. Or, use the school copy machine. If publishing is out of the question, work with your school's newspaper to include a weekly column or a special segment.

Energy Past and Present is based on a project idea submitted by Dinwiddie County Middle School, Dinwiddie, Virginia.

ENERGY TIP HOT LINE

GOAL

To attract interest in NEED Week activities and in energy education by coupling well known/popular/famous personalities with an energy message.

BACKGROUND

In advertising everyone recognizes the value of pairing a famous face with a product. This activity draws upon this fact and uses it to promote energy education messages. The person may be someone very famous (i.e. former President Ronald Regan was invited and agreed to be one of the personalities in Schaumburg, Illinois) or a local radio or TV celebrity, school superintendent, the mayor, etc. Students in grades 5 - 12 would be suitable candidates for this acitivity.

HOW TO ORGANIZE

STEP 1 Brainstorm a list of potential personalities.

STEP 2 Develop a lead/introduction that each personality could deliver prior to a student's energy message. (For example: Hello! This is _____. You've reached the NEED Hotline. NEED stands for the National Energy Education Development Project and is being celebrated this year on _____ by the students at _____. Listen carefully to the following messages. Thank you.) Then, a pre-recorded energy message by a student or students would follow.

STEP 3 Brainstorm, prepare, and record a series of messages to be delivered by students. For example: "Did you know that by recycling three aluminum cans a day you save one kilowatt-hour of electricity?"

Switch your answering machine to only play back your message. You do not want to allow a caller to leave a message.

STEP 4 Send a letter of invitation to each person on your list along with a blank cassette tape and a postage paid return envelope. Explain who you are and your goals in this activity. Ask them to record the lead (provide them with a script) and to return the recorded lead to you by a specific date. Be sure to follow up later with a thank you letter.

STEP 5 Get someone to donate a telephone line to be used exclusively for this Hot Line message. Check with your local telephone company, a local business or your school system.

This activity idea was submitted by Mrs. Karen White, Hoover Elementary School, District 54, Schaumburg, Illinois.

THE SENATE ENERGY HEARINGS

GOALS

To conduct a mock Senate Hearing on a controversial energy issue.

To develop cooperative, research, decision-making, and public speaking skills in students from the eighth through the twelfth grade.

BACKGROUND

This activity is ideal for American history or civics classes, though it is not restricted to these fields. Students will gain an in-depth knowledge of a controversial energy topic, as well as an understanding of the politics and science behind national issues, along with a first-hand view of how a Senate Hearing is conducted. Each Senate Energy Hearing requires from 5 - 7 students.

HOW TO ORGANIZE

STEP 1 Have everyone in the group read and discuss the Group Contract sheet (available in the NEED Activities Guide). Then, the group should come together and build their own group contract. Every member of the group should have some input. After the contract is finished, it should be signed by every member of the group.

*** Hand a copy of your group contract with signatures to your teacher.

STEP 2 Now the group should decide on an issue to discuss. The best issues will be controversial and relatively timely. Included in this Kit are two NEED Backgrounders that are adaptable to the Senate Energy Hearings: the CAFE Backgrounder and the Petroleum Backgrounder. Both of these present both sides of a complex energy issue. There are many other energy issues that are suitable, such as the debate over nuclear power, clean air, or a "carbon tax." The NEED Energy Education Poll can point out controversial issues in its opinion questions.

Even if one of the Backgrounders is used, the group will probably want to do additional research. If the group is using another topic, they will need to do extensive research. Reference books are the best place to start. Once the group has a solid foundation of the facts and history surrounding the topic, they will need to understand the current issues. There are several sources a group can use:

1. The Reader's Guide to Periodical Literature. This reference work will help find recent magazine articles on the group's topic. Ask a librarian for more specific help.

2. Back issues of *Energy Exchange* magazine. If your school has been a member of the NEED project for any length of time, copies of the magazine should be available. Many issues feature Point/Counterpoint articles written by members of Congress with opposing viewpoints, as well as good informational articles. For example, in the Fall 1989 edition, Senator Metzenbaum (D – OH) and Senator Nickles (R – OK) discuss their opposing views on CAFE.

3. Local energy experts. Chances are, somewhere near your school are people to whom these are not just academic issues. There are people who work in the energy business, whether they are from your local utility company, your state energy office, a local college or university, or elsewhere, who are probably willing to at least speak to students over the phone about these energy issues.

4. Local Congressional offices. In addition to the local office of your U.S. Representative and Senator, your state Congress can be a useful source of information. Most politicians have a stance on energy issues, and might be willing to talk to students about them. To be on the safe side, contact these offices about two to four weeks in advance of needing anything from them. If nothing else, these offices may be able to provide testimony from an actual Senate Energy Hearing.

*** If you are using your own topic, you will probably need to photocopy and/or check out reference books and magazines. Show these to your teacher along with other notes that you have made during your research. Also, whether using a NEED Backgrounder or your own research, prepare an issue outline of your topic. Summarize each argument in the issue – one half to one page in length.

OPTIONAL: You may want to use actual energy experts as expert witnesses for the hearing. One or two can serve. If

you can obtain two, try to have them from opposing sides of the argument. These people need to be contacted three to four weeks in advance of the Hearing. Many experts will welcome the chance to share their viewpoints with the class.

STEP 3 Now that you have done the bulk of your research, the group needs to talk about differences in Senators. The home state of a Senator will help determine how he or she feels about an issue. For example, a Senator from California will probably feel differently about offshore oil drilling than a Senator from Iowa. The Californian would have to deal with the drilling off his shores, while the Iowan would not. Remember that a Senator wants to protect his home state and people. A Senator from Michigan (whose economy is dependent on the car industry) would probably oppose any laws that could damage the car industry. Make sure that you consider a wide variety of states and Senators.

STEP 4 After your group has talked about the regional and political differences in Senators, you need to decide which Senators from which states will serve on the hearing panel. As many as five Senators can serve – four on the panel and one chairperson. No matter how many Senators you have, one must serve as the chairperson. If you have more than five people in the group, the others will be energy expert witnesses. It is best to have at least one expert witness.

*** Now decide who in your group will be who. Write down who in your group will be Senators, including their home state and party (for example: Don Harrison will be Senator Harrison, (D – California). If you have expert witnesses, determine how they feel about the issue and give them a "job." For example, if you have an expert witness in favor of the oil industry, give him or her a title and a job with an oil company like Mobil. If the expert witness is an environmentalist, say that he or she is from the Sierra Club, or another group. Make sure everyone understands which side of the issue they will be presenting. This should be as even as possible. A group of six people (one expert witness and five Senators) should be able to present every side on any issue. When you have completed the list, hand it in to your teacher.

STEP 5 At this point, Senators and expert witnesses who share the same viewpoint on an argument may wish to work together in order to present an effective argument on that issue. Remember, however, that you are not trying to beat the other group in a formal debate. You are trying to present the facts to the audience.

Every member of the group will need to write a one to two minute opening statement that expresses his or her viewpoints. In addition, all the Senators must write two questions for each expert witness who will be testifying. These questions should be chosen to support the viewpoint of the Senator. For example, a Senator who supports offshore drilling would not ask a expert witness to describe the possible environmental damage from that drilling.

When the senators have finished their questions, the questions should be given to the expert witness(es) so they can prepare their answers. If you are using adult witnesses, send them the questions so they can prepare their answers.

*** Hand in the opening statements, questions, and answers to the teacher.

STEP 6 Prepare any posters, charts, graphs, slides, or short videos that can enhance the Hearing. Expert witnesses can use these to describe their viewpoints; Senators can use them to illustrate an argument. If you need equipment like a VCR or projector, ask your teacher about obtaining it.

STEP 7 Your group should now have written all the major parts of the Hearing. Put everything together in script form, rewriting any parts if necessary. The script should progress more or less as follows. The chairperson should call the Hearing to order, and then introduce himself or herself and then introduce the other Senators. Then, alternating by opinions, the Senators should give their opening statements. The chairperson should introduce the (first) expert witness, and then the Senators will in turn ask the questions. If there is another expert witness, the chair should introduce him or her, and then the Senators will question that expert witness. Finally, the chairperson will motion for the Hearing to end. Each Senator will give a small (about one minute) closing statement, and then the Hearing will be adjourned.

*** Hand in the final script to the teacher.

STEP 8 Decide what props you'll need for the Hearing. These should be relatively simple. You will need a table or two for the Senators and a table for the expert witnesses. Placecards for everyone will help the audience understand who is involved. If the Hearing is to be held before a large audience, microphones would be helpful. If you do use microphones, make sure all the members of the group have practiced speaking into the microphones and are comfortable with their use. Finally, a gavel for the chairperson to use during the hearing makes a nice touch.

STEP 9 In the time remaining, rehearse your script. It is important to time the Hearing. If it is running only 15 minutes, it is too short. The Hearing should last about 30 to 50 minutes. If your Hearing is not on time, pay attention to detail. If it is too short, add more detail to the questions and answers. If it is too long, take out some details.

It is best if all members of the group memorize their parts as much as possible. It is certainly okay to refer to notes during the Hearing, but reading directly from the script should be avoided.

If time permits, run through the Hearing one or two times. It is very helpful to have your teacher or another student group watch a practice session and then make suggestions. During these rehearsals, you should also make suggestions to other members of the group; just don't be overly critical. Here are some things to watch for during the rehearsal:

- Can you hear and understand everybody?
- Does everyone know his or her part?
- Is the Hearing lively?
- Are all viewpoints fairly represented?

Energy Fact Sheet: Electricity

1989 Facts At A Glance

Classification: *Secondary source of energy*

U.S. Demand: *29quads (37% of consumption)*

U.S. Electricity Production: *2,729 billion kwh*

Major Uses: *Manufacturing, heating, cooling*

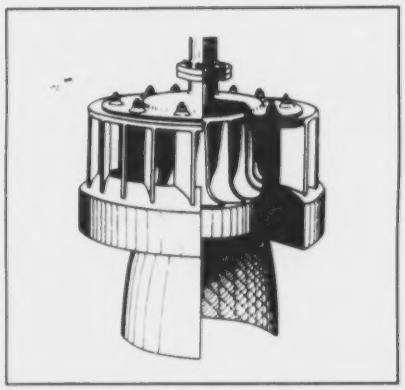
The Nature of Electricity

Electricity is a little different from the other sources of energy that we talk about. Unlike coal, petroleum, or solar energy, electricity is a *secondary*, rather than a primary, source of energy. That means we must use other (primary) sources of energy to make electricity. It also means we can't classify electricity as a renewable or nonrenewable form of energy. The primary energy source that is used to make electricity may be renewable or nonrenewable, but the electricity produced from it is neither.

Producing Electricity

So, just how is electricity produced? Almost all electricity made in the United States is generated by large, central power plants. These plants typically use coal, oil, natural gas, or other energy sources to produce heat energy which superheats water into steam. The very high pressure of this steam (it's 75 to 100 times normal atmospheric pressure) turns the blades of a **turbine**. (In a hydroelectric plant, the force of falling water turns the blades.) The blades are connected to a **generator** which houses a large magnet surrounded by a coiled copper wire. The blades spin the magnet rapidly, rotating the magnet inside the coil and producing an electric current.

The steam, which is still very hot but back to normal pressure, now goes to a condenser where it is cooled into water by passing it through pipes circulating over a large body of water (river, lake, or ocean) or cooling tower. The water then returns to the steam generator to be used again. Today, modern power plants are able to make use of some of the heat from the cooling steam. In old plants, this heat was simply wasted.

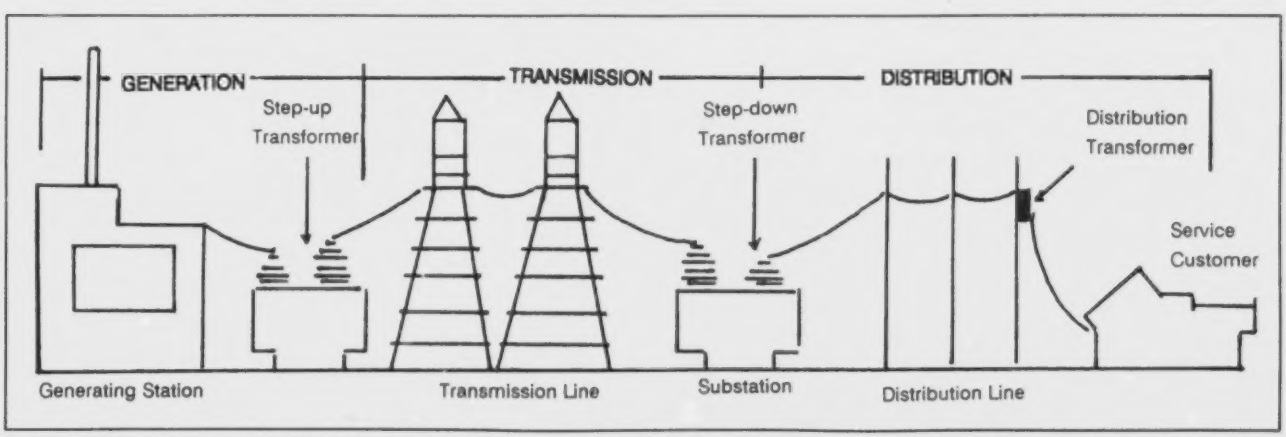


Turbine Generator: *Electricity is made when the blades of the turbine are turned by the force of water, gas, steam, or wind.*

Transporting Electricity from Power Plants to Homes

One reason electrical energy is so popular is the ease with which it moves from one place to another. It can be produced at one location and moved long distances before it is used. After electricity is produced by a generator, it is "stepped up" to a very high voltage by a **transformer**. A transformer steps up the voltage of electricity from the 2,300 to 22,000 volts produced by a generator to as much as 765,000 volts (345,000 volts is typical). Power companies step up the voltage simply because it's more energy efficient to transport electricity over long distances at high voltages.

The electricity is then sent out on a nationwide network of **transmission lines**. Transmission lines are the huge



Electric Power System: *1) Electricity is generated at a power plant. 2) Voltage is stepped up by a transformer. 3) It is sent out on high-wire transmission lines. 4) Voltage is reduced at substations. 5) Distribution lines take electricity to homes and buildings.*

tower lines you may see when you're on a highway. The lines are interconnected; so should one line fail, another will take over the load.

The voltage is usually reduced to 12,000 volts at "step-down" transformers located in substations along the lines. Substations can be small buildings or fenced-in yards containing switches, transformers, and other electrical equipment and structures.

Electricity is then carried over **distribution lines** which deliver electricity to people's homes. Distribution lines may either be overhead or underground. The overhead distribution lines are the electric lines that you see along streets. The voltage is reduced again at another transformer, usually a large gray can mounted on an electric pole, to the 120 and 220 volt levels required for residential electrical appliances and equipment.

Electricity enters a house through a three-wire cable and is connected via an electric meter. The "live wires" are then brought from the circuit breaker or fuse box to power outlets and wall switches in the home. The travel time from power plant to home is instantaneous. In just one second, electricity can move around the earth 7.5 times.

Energy Sources Used to Make Electricity

There are basically three kinds of electric power plants: fossil fuel; nuclear; and hydroelectric. There are also wind, geothermal, trash-to-energy, and solar power plants, but they generate less than one percent of the electricity produced in the United States.

Fossil Fuel Power Plants

Fossil fuel plants may burn coal, natural gas, or oil. In all these plants, the heat energy of the fossil fuel is used to superheat water into steam which, in turn, drives a turbine generator. But the fuel of choice for most electric companies is coal. Today, coal accounts for 57 percent of the electricity generated in the U.S. One problem associated with burning coal to make electricity is air pollution. Scientists are making coal burn cleaner, which would certainly benefit this country, since the U.S. contains 34 percent of the world's known coal reserves.

Nuclear Power Plants

Nuclear plants produce electricity in much the same way as fossil fuel plants except that the furnace is called a reactor and the fuel is uranium. In a nuclear plant, energy is released by splitting uranium atoms into smaller parts. The energy released during fissioning is used to superheat water into steam and the expanding steam drives the turbine. In 1989, nuclear power plants provided 19 percent of the nation's electricity.

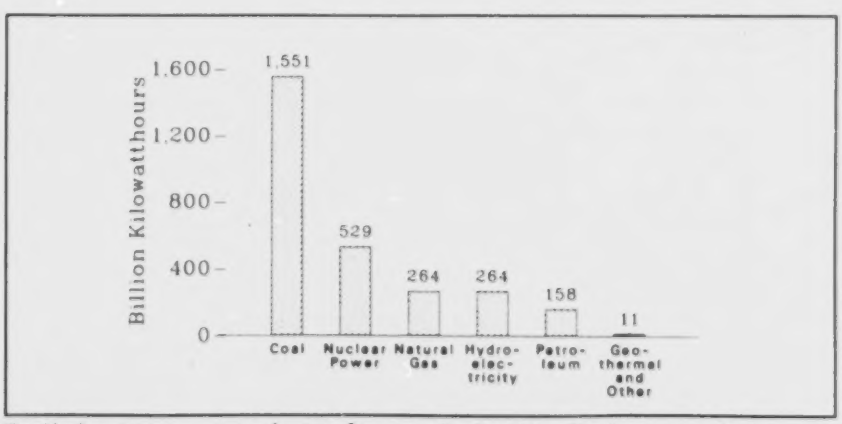
Hydroelectric Power Plants

Hydroelectric plants use the force of falling water to spin a turbine which turns a generator. Hydro (or water) power offers the lowest operating costs of any major form of power generation. But this type of power usually requires a high rate of water flow and a large "head" of water (the height of the falling water). One way to meet this requirement is to build a power plant near an existing dam, or to build a new dam altogether, but there are a limited number of places where dams can be built. Also, building dams may change the ecological balance of an area, possibly flooding large land areas. Hydropower supplies about 10 percent of our electricity today.

(NOTE: Please see NEED's Energy Fact Sheets for more information on these and other primary energy sources.)

Electricity's Consumers (By Sector of Economy)

In 1989, industry used about 35 percent of all the electricity consumed in this country. Manufacturers use electricity for several reasons, but especially because electric power can be generated from a variety of fuels. Commercial consumers (stores, offices, hotels, hospitals) used about 27 percent of the electricity in the U.S. They use about half of their electricity just for heating and cooling. Residential customers used around 34 percent of the electricity consumed in this country, and they used it mainly for heating and cooling. Another three percent of the electricity consumed in 1989 was used for lighting public highways and other miscellaneous purposes.



Coal is the energy source used most often to make electricity. Nuclear energy, hydropower, natural gas, and petroleum are other significant electricity sources. Graphic courtesy of U.S. Dept. of Energy.

Power to the People – Making Sure Electricity Is There When We Need It

Everyone knows how important electricity is to our daily lives. All it takes is a power failure to remind us how much we depend on it. Life would be dramatically different without it – no more instant light from flicking a switch; no more television; no more refrigerators; or stereos; or air conditioners; or video games; or hundreds of other conveniences we take for granted. We depend on it; business depends on it; and industry depends on it. In fact, you could almost say the American economy runs on electricity.

It's the business of electric utility companies to deliver reliable electric service. How do they do it? First, let's

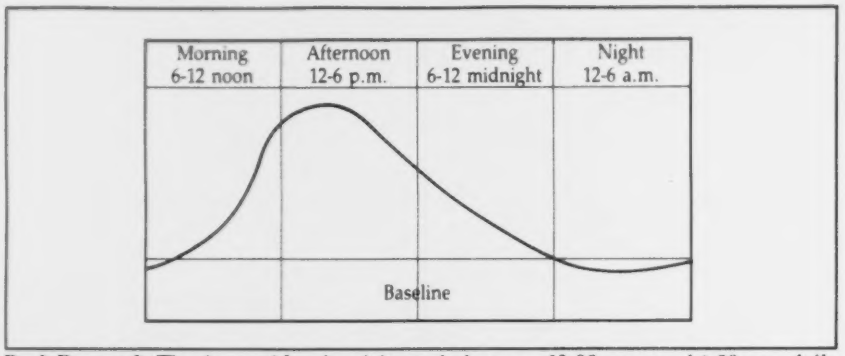
define a few important terms: reliability; capacity; base load; and peak demand.

Reliability is the capability of a utility company to provide electricity to its customers 100 percent of the time. A reliable electric service is one without blackouts or brownouts.

Capacity is the total quantity of electricity a utility company has on-line and ready to deliver when consumers demand it. For example, a utility company that has seven 1,000-MW plants, eight 500-MW plants, and 30 100-MW plants has a total capacity of 14,000 MW.

Base-load power is the electricity generated by utility companies around-the-clock, using the most inexpensive energy sources – usually coal, nuclear, and hydropower. When many people want electricity at the same time it creates a **peak demand**. Power companies must calculate that peak demand and have the necessary power available. During the day's peak, between 12:00 noon and 6:00 p.m., additional generating equipment has to be used to meet increased demand. This equipment is much more expensive to operate. The more this equipment is used, the higher our utility bills. By managing the use of electricity during peak hours, we can help keep costs down.

To ensure reliable electric service, most American utility companies are required by law to have 15 to 20 percent more capacity than peak demand needs.



Peak Demand: *The demand for electricity peaks between 12:00 noon and 6:00 p.m. daily. Reducing our electricity use during this period can help save us money on our monthly electric bills. Graphic courtesy of National Rural Electric Cooperative Association.*

This means a utility company whose peak load was 12,000 MW, would need to have about 14,000 MW of installed electrical capacity.

The use of **power pools** is another way electric companies ensure reliability of their systems. Power pools are cooperative organizations, or individual utilities, linked together within a region which share power as needed. They are coordinated by regional agencies to supply electricity efficiently.

Power pools increase reliability because they are interconnected with "tie-lines;" therefore, a power failure in one system is usually covered by the neighboring system's power until the problem is corrected. There are nine regional power pool networks in North America. The key is to share power rather than lose it.

Power outages in the United States are usually caused by such random occurrences as lightning, a tree limb falling on electric wires, or a car hitting a pole. The reliability of U.S. electric service is excellent, usually better than 99 percent.

Demand-Side Management

Demand-side management is all the things that a utility company does to affect the quantity and timing of electricity demand. Electric companies use demand-side management to level off peak-load periods.

(Continued on page 6.)

Measuring Electric Power

Power *is the rate that energy is delivered. A* **watt** *is a measure of the electric power an appliance uses. It requires a certain number of watts to make an appliance work correctly. All light bulbs are rated by watts, (60, 75, 100 watts) as well as appliances (such as a 1500-watt hairdryer).*

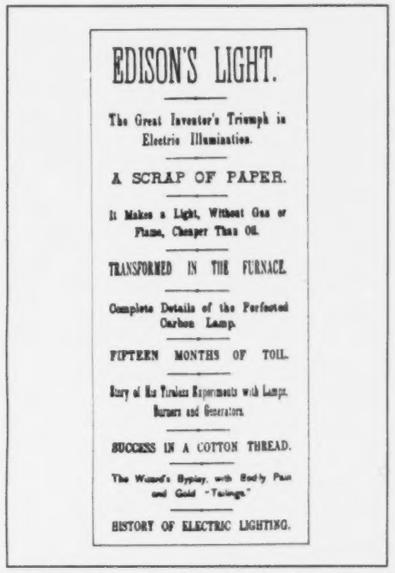
A **kilowatt** *is simply 1,000 watts. For instance, three kilowatts are equal to 3,000 watts. A* **kilowatt-hour (kwh)** *is the quantity of electricity used in one hour at a rate of 1,000 watts. Sometimes it's easier to understand these terms if you compare them to the water in a pool. In this analogy, a kilowatt is a rate, somewhat similar to how fast water is added to the pool. A kilowatt-hour, on the other hand, is an amount, somewhat similar to how much water is added to the pool.*

Whereas we buy gasoline in gallons or wood in cords, we buy electricity in kilowatt-hours. Utility companies charge us a for the kilowatt-hours we use during a month. If an average family of four uses 750 kilowatt-hours in one month, and a utility company charges 10 cents per kilowatt-hour, the family will receive a bill for $75.

Electric companies need to use larger units of measure because they produce huge amounts of electrical power. One **megawatt (MW)** *is equal to one million watts or one thousand kilowatts. Gigawatts are often used to measure the electrical energy produced in an entire state or in all the United States. One* **gigawatt** *is equal to one billion watts, one million kilowatts, or one thousand megawatts.*

Watt = 1 (one)
Kilowatt = 1,000 watts
Megawatt(MW) = 1,000,000 (one million watts)
Gigawatt = 1,000,000,000 (one billion watts)

The History of Electricity



EDISON'S LIGHT.

The Great Inventor's Triumph in Electric Illumination.

A SCRAP OF PAPER.

It Makes a Light, Without Gas or Flame, Cheaper Than Oil.

TRANSFORMED IN THE FURNACE.

Complete Details of the Perfected Carbon Lamp.

FIFTEEN MONTHS OF TOIL.

Story of Its Tireless Experiments with Lamps, Burners and Generators.

SUCCESS IN A COTTON THREAD.

The Wizard's Byplay, with Both Paper and Gold "Tailings."

HISTORY OF ELECTRIC LIGHTING.

On December, 21, 1879, The New York Herald proudly proclaimed Edison's triumph in developing an electric light bulb.

Many people equate the discovery of electricity with Benjamin Franklin's famous experiments establishing lightning as a form of electricity in 1752. Actually, electricity was not "discovered" all at once. Electricity is an action – not really a thing – so different forms of electricity had been discovered in nature. Lightning and static electricity were two forms.

Early on, electricity became associated with illumination or lighting. The reason is pretty obvious. During a thunderstorm, electricity lights up the sky. Likewise, static electricity creates tiny, fiery sparks. The desire for a cheap and efficient means of lighting catapulted efforts by scientists and inventors to research electricity.

The road to developing a practical use of electricity was a long one. Both lightning and static electricity were erratic, lightning also dangerous; so there was a need for reproducing the electrical action on a smaller scale that would also be safe and efficient.

Until 1800, no dependable source of electricity for experiments could be found. It was in this year that an Italian scientist named Alessandro Volta soaked some paper in salt water, placed zinc and copper on alternating sides of the paper, and watched the chemical reaction produce an electric current. Volta had created the first electric cell. By connecting many of these cells together, Volta was able to "string a current" and create a battery. (It is in honor to Volta that we measure battery power in "volts.") Finally, a dependable, safe source of electricity was available, making it easy for scientists to study electricity.

It was clear at this point that the electric age was just around the corner! English scientist Michael Farraday was the first to develop coil electricity used to develop generated power. Farraday realized an electric current could be conducted by passing a magnet through copper wiring. The electric generator and the electric motor, invented later in the 1830's, are based on this principle. (A generator converts mechanical energy into electricity. A motor, in contrast, converts electrical energy into mechanical energy.)

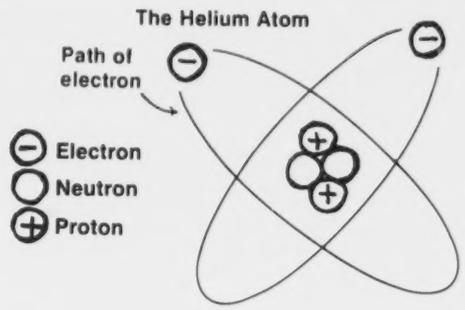
The demand for lighting in homes and businesses had not gone by the wayside. In 1879, Thomas Edison's attention was focused on inventing a practical light bulb, one that would last a long time before burning out. The trick was finding a hardy enough material to be used in the filament, the small wire inside the bulb which conducts the electricity. Finally, Edison used ordinary cotton thread which had been soaked in carbon. The filament did not burn – instead, it became incandescent; that is, it glowed. These new lights were battery-powered, though, and expensive. The next trick was developing an electrical system which would provide people with a practical, inexpensive source of energy.

So Edison went about looking for ways to make electricity both practical and inexpensive. He engineered the first electric power plant that was capable of transporting electricity to people's homes. Edison's power plant included generators, motors, fuses, switches, sockets, meters, transmission lines, and more.

Edison's venture was still quite costly when it was first developed. In today's dollars, the electricity would have cost $5 per kilowatt-hour! In comparison, today's electricity costs an average of eight cents per kilowatt-hour. Edison's Pearl Street Power Station started up its generator on September 4, 1882, in New York City. About 85 customers in lower Manhattan received enough power to light 5,000 lamps.

The turning point of the electric age came a few years later when George Westinghouse and his associates opened a major power plant at Niagara Falls in 1895. The Niagara Falls plant was the first hydro (water) powered electrical plant. While Edison's plant could only transport electricity to within one square mile of his Pearl Street Power Station, the Niagara Falls plant was able to transport electricity over 200 miles!

Electricity didn't have an easy start. While many people were thrilled with all the new inventions sprouting up due to the experimentation with this versatile energy form, many people were afraid of it, wary of bringing electricity into their homes. Also, many social critics, including historians and writers alike, saw it as an end to a simpler, less hectic way of life. Poets of the time commented that electric lights were less romantic than gas lights. But the electric age which had begun was not to be dimmed.

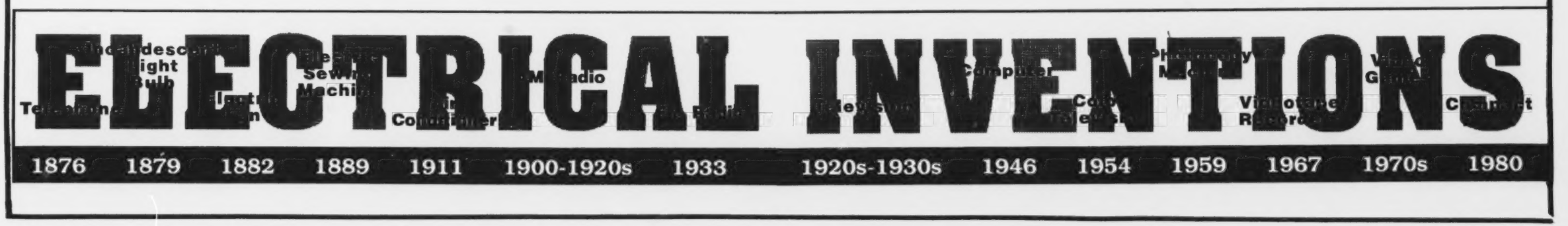


Just What Is Electricity?

Electricity is a fundamental entity of nature. It's all around us. It is abundant in the atmosphere where we can see it in the form of lightning. It's even in our bodies where we can feel it in the form of static electricity. But just what is this colorless, odorless, invisible thing called electricity?

Scientists have spent many years learning about electricity. By observing what it does, they have determined that electricity is not really a thing. Rather it is an action of atoms. Every thing in the world is made up of very tiny particles called atoms. Atoms are so tiny that 12 trillion of them could fit on the head of a pin. All atoms are made up of three kinds of even tinier particles called protons, electrons, and neutrons. Protons and electrons carry electric charges. A proton carries a positive electric charge and an electron carries a negative electric charge; neutrons carry no electrical charges. Electricity happens when the balancing force between electrons and protons is upset by an outside force. When we spin a magnet through a coil of copper wire (a turbine generator), we upset this balancing force and produce electrical energy. Wires are used to conduct this electricity so we can use it for power.

By 1920, about two percent of all the energy in the United States was used to make electricity. Today, about 37 percent of all energy is used to make electricity. Before the end of the century, that figure is estimated to be more than 40 percent.



(Continued from page 3.)

The *quantity* of electricity used can be decreased through better conservation and the use of more efficient electrical appliances and equipment. To illustrate the concepts of conservation and efficiency, we can compare saving electricity with saving water when taking a shower. In this analogy, *conserving* electricity is like turning off the water in the shower while you shampoo your hair. While using electricity more *efficiently* is analogous to installing a better shower head to decrease water flow.

Demand-side management can also affect the *timing* of electrical demand. Some utility companies offer their customers rebates if the customer agrees to allow the utility company to turn off his/her hot water heater (via radio transmitters) during extreme peak demand periods, which occur perhaps 12 times a year. For example, one East coast power company gives a $4 per month rebate to customers participating in its energy-saving program.

Appliance Efficiency

(Reducing electricity demand through use of energy-efficient appliances)

Most homes contain dozens of appliances, from essential ones like stoves and refrigerators, to convenience extras like food processors and deep friers. While the amount of energy used by any one appliance may be small, combined their energy use is significant. Refrigerators in this country, alone, use the electrical output of about 25 large power plants (nearly seven percent of the nation's total electricity consumption).

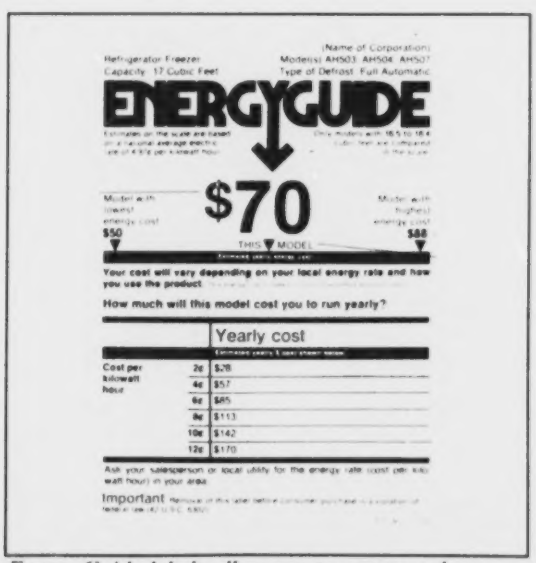
Lifetime Cost Analysis

	Model A	Model B
Purchase Price	$500	$400
Yearly Operating Cost	$70	$120

In the last decade, the job of choosing energy-efficient appliances has been made a little easier. Since 1980, **Energy Guide labels** have been required on seven major home appliances (furnaces, refrigerators, freezers, water heaters, clothes washers, dishwashers, and room air conditioners). The bright yellow and black Energy Guide labels are placed on these appliances by the manufacturer and may not be removed prior to sale.

The labels let you compare the estimated annual operating costs of different appliance models. The best buy may not be the cheapest model. An energy-efficient model may cost more to purchase, but it could save you hundreds of dollars in electricity over its lifetime. As an example, compare the two refrigerators in the table above, each having the same features and capacity, but with different purchase prices and operating costs.

Let's say the refrigerators have a 10-year life. To operate Model A for 10 years would cost $700. Added to the purchase price of $500, its lifetime cost would be $1,200. To operate Model B for 10 years would cost $1,200. Added to its purchase price of $400, its lifetime cost would be $1,600. So, Model A would cost more initially, but would save you $400 in operating costs over 10 years.


ENERGYGUIDE

$70

THIS MODEL

$50

$80

Your cost will vary depending on your local energy rate and how you use the product

How much will this model cost you to run yearly?

	Yearly cost
Cost per kilowatt hour	2¢ $28
	4¢ $57
	6¢ $85
	8¢ $113
	10¢ $142
	12¢ $170

Ask your salesperson or local utility for the energy rate (cost per kilowatt hour) in your area.

Important

Energy Guide labels allow you to compare the energy costs of similar model appliances.

Energy Efficiency Standards

In 1987, Congress passed the National Appliance Energy Conservation Act. The Act established minimum energy efficiency standards for the seven major home appliances, which were already required to have Energy Guide labels, plus standards for heat pumps, central air conditioners, and kitchen ranges. Most of the standards take effect in 1990. The standards for central air conditioners and furnaces will not take effect until 1992 because it will take longer to redesign this equipment.

So how well are we doing to reduce electricity demand through the use of better electric appliances? Fairly dramatic improvements in appliance efficiency have been made since the first oil shock of the 1970's made America more energy conscience. For example, the energy efficiency of freezers has increased 77 percent and that of central air conditioners 40 percent since 1972.

Economics of Electricity

How much does electricity cost? It depends on the fuel used to make the electricity and some other factors as well.

In today's dollars, the price of electricity in 1900 was $5 per kilowatt-hour (kwh). Today, electricity costs an average of eight cents per kwh. Prices had fallen since the early part of this century, until about 1975, when the cost of electricity rose because of higher interest rates, lower demand growth, delay in plant construction (especially for nuclear plants, which can take up to 15 years to build), and the Clean Air Act, which required coal-powered plants to make considerable alterations in order to comply with tougher air pollution standards.

A major key to cost is the particular fuel used. For example, electricity produced from natural gas costs 50-100 percent more than electricity produced from coal or nuclear power.

Another consideration is how much it costs to build a power plant. A plant may be very expensive to construct, but

the cost of the fuel can make it competitive to other plants, or vice versa. For example, nuclear plants are very expensive to build, but their fuel – uranium – is very cheap. Coal-fired plants, on the other hand, are much less expensive to build than nuclear plants, but their fuel – coal – is expensive.

When figuring costs, you must also take into account a plant's efficiency. In theory, a 100 percent energy-efficient machine would change all the energy put into the machine into useful work, not wasting a single Btu of energy. But converting a primary energy source into electricity involves an inevitable loss of energy, usually in the form of heat. Simply put, it takes three Btu's of fuel to produce one Btu in the form of electricity.

In 1900, electric power plants were only four percent efficient; that is, they wasted 96 percent of the fuel used to generate electricity. Today's power plants are eight times more efficient with efficiency ratings of about 35 percent. This means, in other words, that about 65 percent of the initial heat energy used to make electricity is lost. (You can see this heat "waste" in the great clouds of steam pouring out of giant cooling towers or newer power plants.) A modern coal plant burns about 8,000 tons of coal each day, and some two-thirds of this is lost when the heat energy is converted into electrical energy.

But that's not all. About two percent of the electricity generated at a power plant must be used on the site to run equipment. The pumps used to circulate water at a power plant are particularly big energy consumers. And then, even after the electricity is sent out over electrical lines, another 20 percent of the electrical energy is lost in transmission. Of course, consumers pay for all the electricity generated whether "lost" or not.

The cost of electricity is also affected by what time of day it is used. For example, during a hot summer afternoon from 12:00 noon to 6:00 p.m., there is a peak of usage when air-conditioners are working harder to keep buildings cool. Electric companies charge their industrial and commercial customers more for electricity during these peak load periods because they must turn to more expensive ways to generate power.

Independent Power Producers

The business of generating electricity was once handled solely by electric utility companies, but today many others are generating – and selling – electricity. Independent power producers (somtimes called *private power producers*, or *non-utility generators*) may generate electricity using traditional means (coal or gas-fired boilers, for example) or they may use such renewable energy sources as hydropower, solar, geothermal, wind, and biomass.

The trend toward using independent power producers to supplement the electricity production of public power companies can be traced back to the oil crises of the 1970's. At that time, Congress wanted to encourage greater efficiency in energy use and the development of new forms of energy. So in 1978, Congress passed a set of energy laws including the **Public Utility Regulatory Policies Act** or **PURPA**. This new law dramatically changed the relationship between electric utilities and smaller, independent power producers.

Under the law, a utility can not ignore a nearby, independent power producer. The law says utilities have to purchase power from an independent power producer if 1)the private power producer is a "qualifying facility," 2) the utility has a need for the electricity, and 3) the price of electricity is less than what it would have cost the utility to provide it.

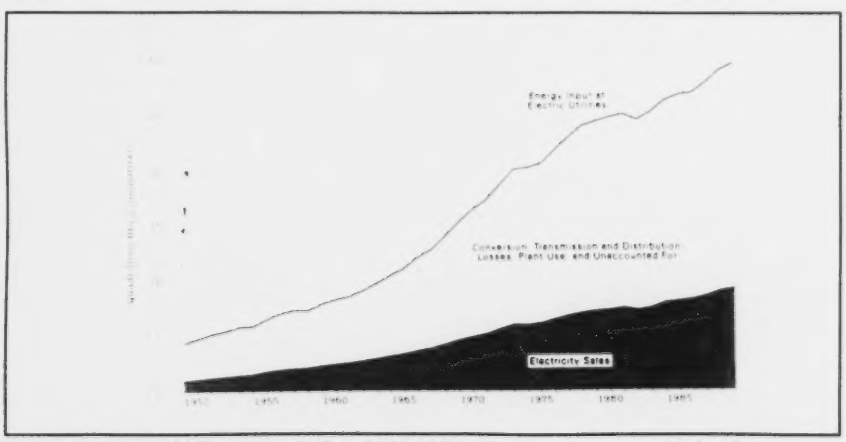
The relationship between independent power producers and utilities varies from state to state. Some utilities welcome the independent power producers because they help them meet the growing demand for electricity in their areas without having to build new – and expensive – power plants.

Other utilities are concerned that power from independent producers will make their systems less reliable. They fear that this may cause industries to think twice before locating in their areas. For completely different reasons, some environmentalists are also concerned about increasing our reliance on independent power producers for electricity. They are concerned because the independent producers may not be subject to the same pollution control standards.

In any case, most experts predict that the quantity of electricity produced by independent power producers will double in the coming decade. Today, independent power producers generate about two to three percent of the nation's electricity, about the same amount of electricity produced by 20 large nuclear power plants. In comparison, experts estimate that more than five percent of the electricity produced in this country will be generated by non-utility generators in the year 2000.

Cogeneration

One special type of independent power production is **cogeneration**. Cogeneration, although not a new concept – Thomas Edison used cogeneration back in the late 1800's to produce electricity – took off after the oil crises in the 1970's as an effort to save energy.



Energy Input and Electricity Sales, 1949-1989: *Today, about two-thirds of the energy input at electric power plants is lost during energy conversion, transmission, plant use, etc.*

Congeneration is really an energy conservation technique whereby electricity and steam are produced from the same fuel at the same time. Industrial and manufacturing plants often generate their own electricity as a way to save money and to make sure they always have a reliable source of energy they can control. In all methods of electricity production, some of the energy used to make electricity gets wasted. At a thermal (coal, oil, gas, nuclear) power plant, the fuel is burned to superheat water into high-pressure steam. The steam then turns the blades of a turbine to generate electricity. But a lot of the heat energy in the steam is wasted – there's no use for it. We can save this energy by using it for "space" heating (heating buildings) or for industrial purposes.

Cogenerators differ from electric utilities in that they use most of the energy themselves. But today some cogenerators sell the extra energy they do not use to electric utilities. The electric utilities in turn supply that energy to their customers. So even though your family's electric bill may come from an electric utility, the electricity you used may have come from a chemical plant, a paper mill, or even a fast food chain.

Today, many cogenerating facilities are located in California and Texas where there's heavy industry and manufacturing. In 1989, roughly seven percent of all energy produced in the U.S. was cogenerated, and by 1995 that figure will probably double.

Future Electricity Demand

What does the future hold for electricity? We're sure to need more of it. The Department of Energy predicts electricity will supply 40 percent of our energy needs in the year 2000. Currently, it supplies about 37 percent.

This is true despite the fact that we use *less* energy per person each year in the U.S. The total demand for electricity has gone up. Prior to 1973, there was an increased demand of seven percent a year, which had a doubling effect every ten years. Since that time, the demand for electricity has increased just 2.5 percent per year.

Experts predict that we will need 72 thousand more megawatts of generating capacity by the year 2000. To illustrate how much more electrical capacity that is, let's think of one 1,000 MW power plant. A 1,000 MW power plant is about the size of a large nuclear plant. If we will need 72 thousand more megawatts of generating capacity by the turn of the century, that means we will need the equivalent of 72 more nuclear plants to meet increased demand needs.

Or you can think of our future demand needs in terms of coal plants. Since the average coal plant is about 600 MW, that means we will need 120 more coal plants by the year 2000.

Experts also say the mix of energy sources used to generate electricity will change in the coming years. Most significant, the quantity of electricity produced by independent (non-utility) power producers is expected to double in the coming decade, from two to three percent today to more than five percent in the year 2000.

Electricity R & D – What does the future hold?

Superconductivity

Superconductivity was actually discovered in the laboratory about 75 years ago, long before there was any adequate theory to explain it. What is superconductivity? Basically, superconductivity is the loss of virtually all resistance to the passage of electricity through some materials. Scientists found that as some conducting materials are cooled, the frictional forces that cause resistance to electric flow suddenly drop to almost nothing at a particular temperature. In other words, electricity could remain flowing without noticeable energy loss even after the voltage was removed.

Until just a few years ago, scientists thought that superconductivity was only possible at temperatures below -419 Fahrenheit. Conducting materials – like pure metals – could only be maintained in a superconducting state through the use of liquid helium. But new ceramic-like materials have been shown to be superconducting at temperatures as high as -270 F. Because these new materials can maintain their superconducting state through the use of liquid nitrogen, the economics of superconductivity suddenly became practical. Whereas the cost of liquid helium is $11 per gallon, the cost of liquid nitrogen is 22 cents per gallon.

Some obstacles remain in the way of incorporating this new technology into commercial products however. First, most experiments so far have only involved very small samples of these materials, which tend to be very brittle and difficult to shape. Second, the ability of these materials to carry large electric currents without loosing superconductivity has not been determined.

Still, the development of the new superconductors has the potential to dramatically change, perhaps even revolutionize, the electronics, electric power, and transportation industries.

Fusion Energy

Nuclear energy is energy that comes from the nucleus (core) of an atom. Nuclear energy can be released from an atom by one of two processes: nuclear fission or nuclear fusion. In nuclear fission, energy is released when the nuclei of atoms are split apart. Conversely, in nuclear fusion, energy is released when the nuclei of atoms are combined or fused together. Today nuclear fission is the only method used by nuclear power plants to generate electricity.

But scientists are working on ways to make fusion energy possible. The problem is that fusing atoms together requires incredibly high temperatures – around 270 million degrees Fahrenheit! To date, fusion machines have managed to obtain the required fusion temperatures, but for less than one second. This means that much more electricity was used to create the high temperature than was released from the very brief fusion reaction. Fusion energy holds much promise, but it probably won't be a practical energy source for producing electricity until well into the next century.

Printed on recycled paper

U.S. Electric Power Generation Sources

Name	1989 Statistics	Ranks	Your Ranks	Error Points	Group Ranks	Error Points
Biomass	Biomass produced 1,965 million killowatt-hours of electricity. This represents less than 0.1 percent of the nation's electricity. Biomass energy is the result of burning wood and solid waste.	7				
Coal	Eighty percent of the nation's coal is consumed by electric utility companies to produce electricity. Coal produced 1,551,852 million killowatt-hours of electricity, which is fifty-seven percent of the nation's electricity.	1				
Geothermal	Geothermal energy produced 9,342 million killowatt-hours of electricity, chiefly from geothermal facilities in the western United States. Geothermal energy produced 0.33 percent of the nation's electricity.	6				
Hydropower	Almost ten percent of the nation's electricity was generated by 2,000 dams nationwide. Hydropower produced 265,061 million killowatt-hours of electricity. It is the leading renewable source used to provide electricity.	3				
Natural Gas	Natural gas produced 264,957 millon killowatt-hours of electricity, generating ten percent of the nation's electricity. Approximately one-half of this natural gas was used by gas turbines to provide electricity during peak hours of demand.	4				
Uranium	One hundred and nine nuclear power stations provide the nation with almost twenty percent of its electrical energy needs. Uranium produced 529,355 million killowatt-hours of electricity.	2				
Petroleum	Petroleum provided six percent of the nation's electricity last year through 158,241 million killowatt-hours of electric power generation.	5				
Propane	There are no statistics available for propane's contribution to electrical production. Very litttle propane, if any, is used to produce electricity.	10				
Solar	Solar provided less than 0.0001 percent of the nation's electricity last year through 2.6 million killowatt-hours of electricity. Most solar generated electricity comes from thermal solar sources, and a small amount from photovoltaics.	8				
Wind	Wind energy produced 0.5 million killowatt-hours of electricity. Wind energy provides less than 0.0001 percent of the nation's electricity. Ninety-five percent of the nation's wind generated electricity is produced in California.	9				

TOTAL _____ _____

Error points are the absolute difference between your ranks and EIA's (Disregard plus or minus signs).

Source: Energy Information Administration

Scoring for individuals:

0-12 – excellent
13-18 – good
19-24 – average
25-30 – fair
31-36 – poor
37-42 – very poor

Energy Fact Sheet: Electricity

The Nature of Electricity

Electricity is a little different from the others sources of energy that we talk about. Unlike coal, petroleum, or solar energy, electricity is a *secondary*, rather than a primary, source of energy. That means we must use other (primary) sources of energy to make electricity. It also means we can't classify electricity as a renewable or nonrenewable form of energy. The primary energy source used to make electricity may be renewable or nonrenewable, but the electricity produced from it is neither.

Making Electricity

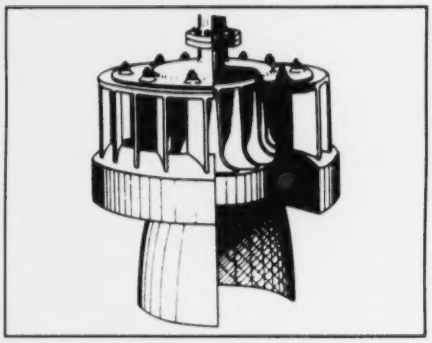
So, just how is electricity made? Almost all electricity made in the United States is generated by large, central power plants. These plants typically use coal, oil, natural gas, or other energy sources to produce heat energy which is used to superheat water into steam. The very high pressure of the steam turns the blades of a **turbine**. The blades are connected to a **generator** which houses a large magnet surrounded by a coiled copper wire. The blades spin the magnet rapidly, rotating the magnet inside the coil and producing electricity.

Transporting Electricity from Power Plants to Homes

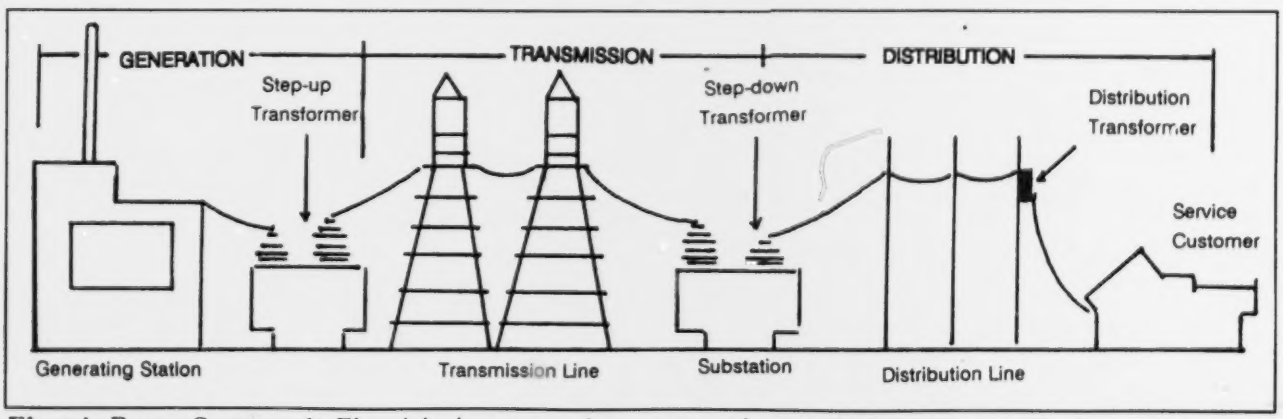
One reason electricity is so popular is the ease with which it moves from one place to another. It can be made at one location and moved long distances before it is used. After electricity is produced by a generator, it is "stepped up" to a very high voltage by a **transformer**. Power plants step up the voltage simply because less energy is lost in transport when it's at a high voltage.

Power plants then send the stepped-up electricity on a nationwide network of **transmission lines**. Transmission lines are the huge tower lines you may see when you're on a highway. The lines are interconnected, so should one line fail, another will take over the load.

The voltage is reduced at "step-down" transformers located in substations along the lines. Substations can be small buildings or fenced-in yards containing switches, transformers, and other electrical equipment and structures.



Turbine Generator: *Electricity is made when the blades of the turbine are turned by the force of steam, water, gas, or wind.*



Electric Power System: *1) Electricity is generated at a power plant. 2) Voltage is stepped up by a transformer. 3) It is sent out on high-wire transmission lines. 4) Voltage is reduced at substations. 5) Distribution lines take the electricity to homes and buildings. Illustration courtesy of National Rural Electric Cooperative Association.*

What Is Electricity?

Electricity is a fundamental entity of nature. It's all around us. It's abundant in the atmosphere where we can see it in the form of lightning. It's even in our bodies where we can feel it in the form of static electricity. But just what is this colorless, odorless, invisible thing called electricity?

Scientists have spent many years learning about electricity. By observing what it does, they have determined that electricity is not really a thing. Rather it is an action of atoms. Every thing in the world is made up of very tiny particles called atoms. Atoms are so tiny that millions of them could fit on the head of a pin.

All atoms are made up of three kinds of even tinier particles called protons, electrons, and neutrons. Protons and electrons carry electric charges. A proton carries a positive electric charge and an electron carries a negative electric charge; neutrons carry no charge. Electricity happens when the balance between electrons and protons is upset by an outside force. When we spin a magnet through a copper wire (a turbine generator), we upset the balance and produce electricity.

Electricity is then carried over **distribution lines** which deliver electricity to people's homes. Distribution lines may either be overhead or underground. The overhead distribution lines are the electric lines that you see along streets. The voltage is reduced again at another transformer – usually a large gray can mounted on an electric pole – to the 120 and 220 volt levels required for the electrical appliances and equipment in homes.

Electricity enters a house through a three-wire cable and is connected to an electric meter which measures how much electricity is used. The "live wires" are then brought from the circuit breaker or fuse box to power outlets and wall switches in the home. The travel time from power plant to home is instantaneous. Electricity travels 186,000 miles per second. In just one second, it can move around the earth 7.5 times.

Measuring Electric Power

A **watt** is a measure of the electric power an appliance uses. It requires a certain number of watts to make an appliance work correctly. All light bulbs are rated by watts, (60, 75, 100 watts) as well as appliances (such as a 1500-watt hairdryer).

A **kilowatt** is simply 1,000 watts. For instance, three kilowatts are equal to 3,000 watts. A **kilowatt-hour** is the quantity of electricity used in one hour. Sometimes it's easier to understand these terms if you compare them to the water in a pool. A kilowatt is the rate of water flow, somewhat like how fast water goes into the pool. A kilowatt-hour is the amount, somewhat like how much water is in the pool.

Whereas we buy gasoline in gallons or wood in cords, we buy electricity in kilowatt-hours. Utility companies charge us for the kilowatt-hours we use during a month. If an average family of four uses 750 kilowatt-hours in one month and a utility company charges 10 cents per kilowatt-hour, the family will receive a bill for $75.

Electric companies need to use larger units of measure because they produce huge amounts of electrical power. One **megawatt (MW)** is equal to one million watts or one thousand kilowatts. Gigawatts are often used to measure the electrical energy produced in an entire state or in all the United States. One **gigawatt** is equal to one billion watts, one million kilowatts, or one thousand megawatts.

Measures of Electricity
Watt = 1 watt
Kilowatt = 1,000 watts
Megawatt(MW) = 1,000,000 (million) watts
Gigawatt = 1,000,000,000 (billion) watts

Energy Fact Sheet: Energy Consumption

Imagine how much energy the United States uses during a single day. Energy for transportation, for our industries and businesses, and for our homes and schools.

The sum of all this energy consumption is roughly equal to the amount of energy stored in 103 thousand barrels of oil. Now if you divide this amount of energy by 246 million Americans – every man, woman, and child – you'll come up with how much energy is consumed each day per person, **or per capita**.

The daily per capita energy use is equal to the amount of energy stored in a little over seven gallons of gasoline. In other words, every man, woman, and child uses the energy equivalent of about seven gallons of gasoline each day. That's also the energy equivalent of approximately 80 pounds of coal or 107 pounds of seasoned hardwood.

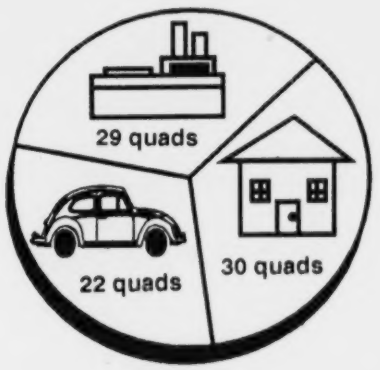
Energy Consumption by Sectors of the Economy

The U.S. Department of Energy classifies energy users into three categories: 1) residential and commercial; 2) industry; and 3) transportation. These categories are sometimes called the **sectors of the economy**.

The residential sector refers to people's use of energy in their homes. Energy consumed by households can be attributed to five applications: space heating, air conditioning, water heating, lighting, and appliance operation. The commercial sector includes office buildings, hospitals, stores, restaurants, schools, and other service-oriented establishments. The residential and commercial sector of the economy consumed almost 30 quads of energy, 36 percent of total energy used in 1989.

The industrial sector of the economy includes manufacturing, construction, mining, agriculture, fishing, and forestry. It consumed over 29 quads in 1989.

The transportation sector refers to energy use by cars, buses, trucks, trains, ships, and airplanes. Last year, the U.S. used large amounts of energy for transportation, a little over 22 quads. Approximately 95 percent of that energy was supplied by petroleum products – gasoline, diesel fuel, jet fuel, and the like.



The Energy Pie: *The three sectors of the economy – residential and commercial; industry; and transportation – used a total of 81 quads of energy in 1989.*

Consumption by Energy Source

Energy sources in the United States include petroleum, electricity, coal, natural gas, nuclear energy, hydropower, propane, geothermal, wind, solar, and biomass.

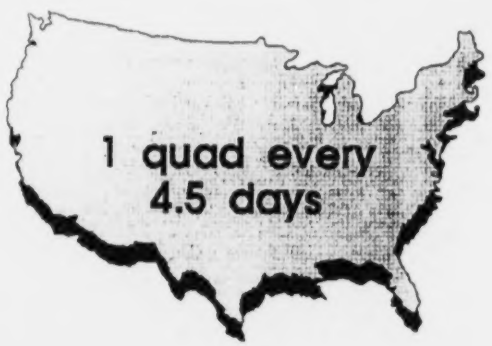
Petroleum products, almost half of which is gasoline, provided the nation

Measuring Energy

We buy gasoline in gallons, wood in cords, and natural gas in cubic feet, but the heat energy contained in these and other energy sources can be measured by one common unit of measure. That unit of measure is **British thermal units** or **Btu's**.

One Btu is the heat energy needed to raise the temperature of one pound of water one degree Fahrenheit. A single Btu is quite small. A wooden kitchen match, if allowed to burn completely, would give off one Btu of energy. One ounce of gasoline contains almost 1,000 Btu's of energy. Every day the average American uses roughly 889,000 Btu's.

At the other end of things, we use the **quad** to measure very large quantities of energy. A quad is equal to one quadrillion (1,000,000,000,000,000) Btu's. The United States uses about one quad of energy every 4.5 days. In 1989, the U.S. consumed approximately 81 quads of energy, an all-time high.



with 42 percent, or 34 quads, of our energy requirements. Imports accounted for more than half the petroleum consumed in 1989.

The U.S. also uses a lot of electricity. In 1989, over a quarter (28.6) of all the energy consumed in the nation was used just to make electricity. (Electricity is a *secondary*, rather than a primary source of energy, which means we must use primary energy sources – such as coal, nuclear energy, hydropower – to make it. Electricity is then used for manufacturing goods, heating and cooling homes, and numerous other purposes.)

Coal and natural gas were also big energy providers, contributing over 19 quads each. Hydroelectric energy provided 2.8 quads and nuclear energy 5.7 quads, both totally for electricity generation. Geothermal, wind, biomass, and solar energy provided only a little over 0.25 quads combined.

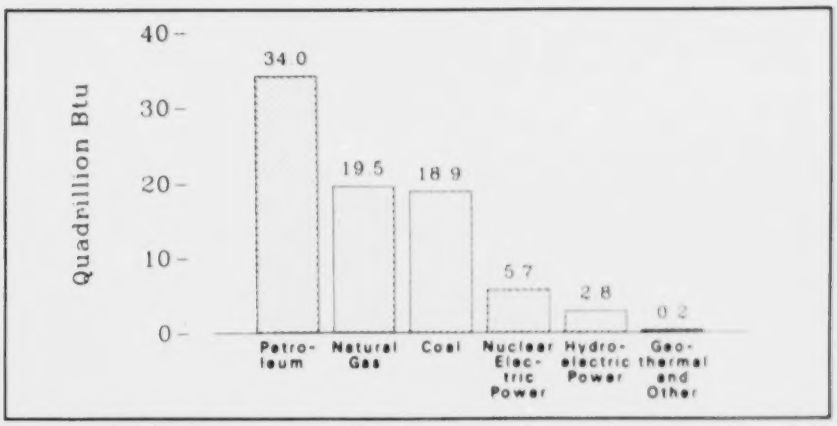
It is estimated by the U.S. Department of Energy that almost 3 quads of energy were produced by burning wood, and from other sources of energy that could not be metered or measured.

Of the 81 quads of energy consumed in the U.S. in 1989, 65.7 quads came from domestic energy sources. While another 18.7 quads of energy were provided by imports, chiefly petroleum imports. (The U.S. exported about 4.7 quads of energy to other countries. Coal accounted for most of our energy exports.)

Energy Consumption Trends

The forces that govern how we use energy were not well understood in 1973 when the first oil price shock occurred. Energy analysts have since learned that consumers and producers are more responsive to energy prices than previously believed.

The U.S. economy has demonstrated an impressive ability over the past 15 years to reduce energy consumption in response to increasing prices. The United States uses about seven percent more energy today than it did in 1973, yet there are over 20 million more homes, 50 million more vehicles, and the nation's **gross national product** (the total value of all the goods and services produced by the people of a nation in one year, also called GNP for short) is 46 percent higher.



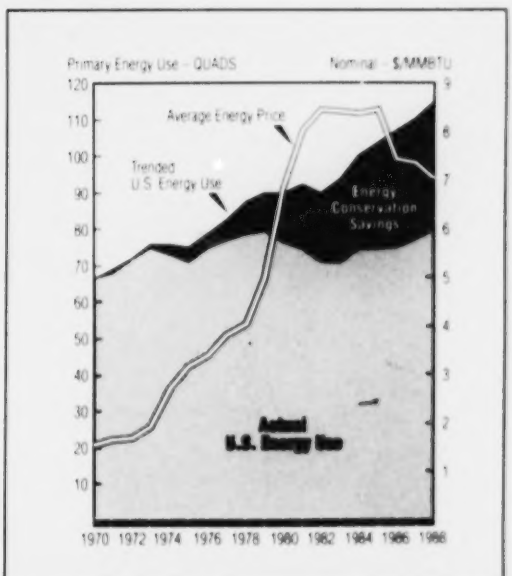
Consumption by Energy Source: *Petroleum, natural gas, and coal were the nation's biggest energy providers in 1989. Graphic courtesy of U.S. Dept. of Energy.*

One of the major lessons of the period since 1970 is that the American economy will respond to energy price changes. Figure 1 shows us three things: 1) actual energy use in the U.S. since 1970; 2) the predicted energy use based on energy consumption *before* the energy price increases in 1973 (that is, how much energy analysts thought we would be using before the big price increases in the 1970's); and 3) the average U.S. energy price since 1970. A comparison between actual and predicted energy use is revealing.

The first significant deviation from the trend occurred the same year that energy prices increased sharply. In that year, energy use dropped, creating a gap between actual energy use and the projected energy use trend. When energy prices took off again in 1979 and 1980, energy used declined once more, widening the gap between actual and projected energy consumption. When energy prices started to decrease in 1985, energy use began to creep up, returning to the trend's rate of growth.

What does this tell us? Simply put, consumers and businesses respond to energy price increases by using energy more efficiently. That is, when prices increase, we use less energy than we would have if prices had remained steady. Then, when energy prices fall, people don't quickly return to old energy-wasting habits, although energy conservation does slow.

The price of energy is not the only factor in the equation. Other factors which affect energy consumption trends include new technology which improves the efficiency and performance of products, and, secondly, public concern for the environment.



The price of energy affects U.S. energy use. Higher energy prices encourage energy conservation, while lower energy prices slow conservation. Graphic courtesy of U.S. Department of Energy.

Energy Fact Sheet: Biomass

Facts At A Glance

Classification: Renewable

Percent U.S. energy consumption: 3.5% *

Percent U.S. energy production: 4% *

Major Uses: Heating and transportation

* Estimates based on 1987 figures, the latest available.

What Is Biomass?

Biomass is a renewable source of energy that is derived from the solar energy stored in plants and animal waste. It's probably the oldest source of energy known. For thousands of years, people have burned wood to heat their homes and cook their food.

All organic matter – plants, seaweed, grain, waste products, etc. – contain stored energy from the sun. During a process called **photosynthesis**, sunlight provides the energy which enables the chlorophyll in plants to combine water, carbon dioxide, and minerals to form carbohydrates. These carbohydrates supply plants (or the animals who consume these plants) with energy. (In fact, you can think of petroleum, coal, and natural gas as *fossil* forms of biomass since they were formed from the remains of ancient plants and sea animals.)

Converting Biomass into Energy

The energy stored in biomass may be released in one of four ways:

The simplest method is **direct combustion** or burning. Various forms of biomass can be burned to produce steam for making electricity or to provide heat for industries and homes. Burning wood for heat is an example which quickly comes to mind.

The second method is **anaerobic digestion**, which simply amounts to bacteria feeding on the biomass, and consequently producing **methane** gas. This occurs whenever waste decays; it is a natural process.

The third method is **gasification** or **liquifiction**. This simply means converting biomass into a gas or liquid fuel by using either a chemical or heat process.

A fourth method is **fermentation**. In fermentation a yeast is added to biomass, producing an alcohol known as ethyl alcohol, or **ethanol**.

Types of Biomass Energy

There are four main types of biomass energy sources that are used to produce energy today: 1) wood and agricultural products; 2) solid waste; 3) landfill gas; and 4) alcohol fuels. We'll talk about each of these below.

Wood and Agricultural Biomass

In a sense, most of the biomass used today is home grown energy. Wood accounts for about 90 percent of all biomass energy. Wood logs, chips, bark, and sawdust are the most common type of woody biomass fuel. But any organic matter can be used to produce biomass energy. Other biomass sources include agricultural waste products like fruit pits, corn cobs, rice hulls, vineyard clippings, and coconut husks. Sometimes fast-growing plants like sugar cane are harvested for the specific purpose of providing energy. The ideal energy crop grows well on marginal land, thrives without fertilizers, protects the soil from erosion, and requires little energy or capital for energy conversion.

Land-grown plants are not the only beneficiaries of sunlight. Sunlight falling on the earth's waters is also stored in many fast-growing aquatic plants. Although **aquaculture**, which reaps the benefits of organisms naturally present in water, is still an infant science, the long-term prospects for harvesting aquatic plants for energy are great. On top of this, these plants do not compete with food crops for fertile land, fresh water, or fertilizers. Nature has already provided them!

So, just how are wood and agricultural biomass energy sources put to work? The old-fashioned and most simple method is direct combustion or burning. For example, the lumber industry gets about 45 percent of its energy by burning its own wood waste products.

The more modern method, gasification, converts biomass into a gaseous fuel. This fuel can be burned like natural gas to produce heat or steam, or converted once again to make synthetic liquid fuels.

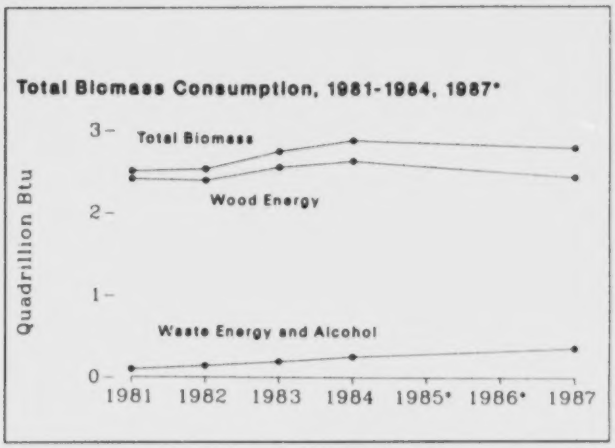
Solid Waste

There is nothing new about people burning trash. What is new is burning trash to generate electricity. In this way, waste is turned into a useable form of energy. In fact, a ton of garbage contains about as much energy as 500 pounds of coal. That's enough energy to generate 525 kilowatt-hours (kwh) of electricity, or enough electricity to heat a typical office building for one day.

Plants that burn garbage for energy are called **waste-to-energy** plants or **resource recovery** plants. These plants generate electricity in much the same way that coal-fired plants do except that garbage – not coal – is the fuel used to fire an industrial boiler. Following the same formula as a coal-fired plant, the heat energy produced when garbage is burned is used to boil water into steam. This steam then turns the blade of a turbine to generate electricity. A typical waste-to-energy plant can burn about 3,000 tons of garbage a day.

There are currently 120 such plants in the United States. Together they burn about 13 percent of the nation's garbage. Japan and West Germany, on the other hand, burn more than twice that amount in waste-to-energy plants.

If the only reason for burning garbage was for its energy value, it wouldn't be as



The use of wood energy has declined slightly in recent years while the use of other biomass resources has increased slightly. Graphic courtesy of U.S. Dept. of Energy.

cost-effective as other fuel sources. However, burning solid waste could reduce the amount of garbage dumped in landfills by 60 to 90 percent percent, reducing the cost of landfill disposal and saving precious space in the fill.

Landfill Gas

The process of anaerobic digestion takes place in landfills to produce **methane** gas. Methane, sometimes simply called natural gas, is a good energy fuel and is used in both homes and industry. Most gas furnaces and gas stoves, for example, use methane supplied by natural gas utility companies.

New regulations dealing with landfills in the United States *require* the collection of methane gas from landfills for a couple of reasons. First, the odor of methane gas is very unpleasant to say the least. Second, there is a potential for fire or explosions if the gas seeps into nearby homes and is ignited.

The gas that is collected need not be wasted; it can be put to work. For instance, it can be used as a heating fuel or as a fuel for generating electricity. In one case history, the town of Florence, Alabama recovers 32 million cubic feet of methane gas a day from its municipal landfill. The city simply processes the gas and then pumps it into the city's natural gas pipelines.

But a very small percentage of methane gas is recovered and used to produce useable forms of energy. With today's low natural gas prices, the higher-priced "biogas" has a difficult time competing.

Alcohol Fuels

Wheat, corn, and other crops can be used to produce a variety of liquid fuels including ethanol, methanol, and gasoline. Typically though, the process of fermentation is used to convert corn into **ethanol**, an alcohol fuel which may be best known as the intoxicating agent in beer, wine, and liquor.

But the use of ethanol as a motor fuel is not really new; it's almost as old as the automobile itself. In the early 20th century, automobile pioneer Henry Ford promoted **gasohol**, a mixture of ethanol and gasoline, in an effort to diffuse an impending oil shortage and to stimulate demand for farm products.

Today, ethanol is a relatively high cost fuel, however, and the use of it has become a somewhat controversial issue. It is estimated that a barrel of oil will have to more than double in price before ethanol can compete with gasoline as a transportation fuel. In spite of this, the ethanol industry has continued to grow, in large part because the federal government exempts ethanol fuels from the federal highway tax. Currently, this exemption is set to run out in 1993, but ethanol proponents are lobbying Congress to extend the exemption until the year 2000.

Because ethanol is expensive, and because cars can only run on pure ethanol if the engines undergo certain changes, ethanol is usually mixed with gasoline to produce gasohol. (Cars can run on gasohol without any adjustments.)

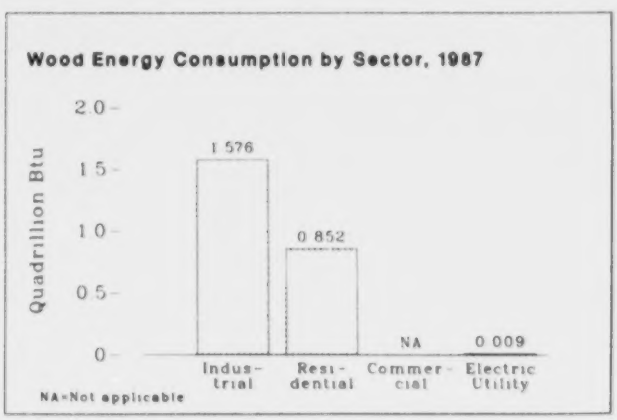
Gasohol is ten percent ethanol and 90 percent gasoline. In 1989, eight percent of the nation's motor fuel consisted of this ethanol and gasoline mixture. In some areas of the nation, in corn-growing states for example, gasohol use is as high as 50 percent.

Gasohol does have some advantages though. It has a higher octane rating than gasoline (provides your car with more power), and it's cleaner-burning than unleaded gasoline, with one-third less carbon monoxide emissions. Ethanol fuel proponents also say that gasohol helps reduce America's dependence on foreign oil.

Consumption of Biomass

Until the mid-1800's, wood supplied about 90 percent of the energy consumed in the United States. Today, biomass provides only 3.5 percent of the nation's energy needs. Ninety percent of this amount is produced by the direct combustion of wood and wood wastes. The remainder comes from agricultural wastes, solid waste, landfill gas, and ethonol.

Who uses biomass energy? By far, industry is the largest consumer of biomass energy. As case in point, the lumber industry supplies approximately 45 percent of its energy needs from its own wood and waste. Homes are the next biggest users of biomass energy. About a quarter of all U.S. homes burn wood for heating. Five percent of these homes use wood as their main heating fuel. To a much lesser degree, electric utilities also use biomass energy to produce electricity.



Industry is the primary user of biomass energy. Graphic courtesy of U.S. Dept. of Energy.

Printed on recycled paper

Energy Fact Sheet: Coal

1989 Facts At A Glance

Classification: *Nonrenewable*

Reserves: *300 years*

Percent of U.S. energy production: *31%*

Percent of U.S. energy consumption: *24%*

Major Use: *Electricity (85% of coal used for electricity)*

NOTE: *One ton of coal is equal to 4 barrels of oil, 22,000 cubic feet of natural gas, or one cord of seasoned hardwood.*

What Is Coal?

Coal, a nonrenewable source of energy, is a fossil fuel created from the remains of plants that lived and died about 100 to 400 million years ago when the earth was covered with huge swampy forests.

The energy we get from burning coal today comes from the energy that plants absorbed from the sun millions of years ago. All living plants store energy from the sun through a process known as **photosynthesis**. After the plants die, this energy is released as the plants decay. Under conditions favorable to coal formation, however, the decay process is interrupted, preventing the further release of the stored solar energy.

Millions of years ago, dead plant matter fell into the swampy water and over the years, a thick layer of dead plants lay decaying at the bottom of the swamps. Over time, the surface and climate of the earth changed, and more water and dirt washed in halting the decay process. The weight of the top layers of water and dirt packed down the lower layers of plant matter. Under heat and pressure, this plant matter underwent chemical and physical changes, pushing out oxygen and leaving rich carbon deposits. What once had been plants gradually turned into coal.

Seams of coal – ranging in thickness from a fraction of an inch to hundreds of feet – may represent hundreds or even thousands of years of plant growth. One important coal seam, the seven-foot thick Pittsburgh Seam, may represent 2,000 years of rapid plant growth. One acre of this seam contains about 14,000 tons of coal, enough to supply the electric power needs of 4,500 American households for one year.

History of Coal in America

North American Indians used coal long before the first settlers arrived in the New World. Hopi Indians, who lived in what is now Arizona, used coal to bake the pottery they made from clay.

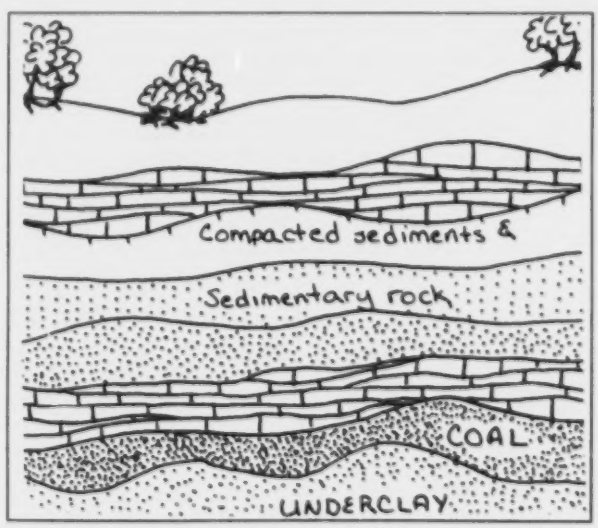
European settlers discovered coal in North America during the first half of the 1600's. At first coal was used very little. Instead, abundant water and wood resources supplied the energy to power most American industries. As wood resources decreased in the 1800's, though, American industries began using the steam engine which Englishman James Watt had invented in 1751. The steam engine used coal to make the steam to run the engine.

In the 1800's coal was used for manufacturing goods and for transportation. Steamships and steam-powered railroads became America's most important forms of transportation. By the time of the American Civil War, coal was also used to make iron and steel. And by the end of the 1800's, coal was even used to make electricity.

As America entered the 1900's, coal had become the energy mainstay for the nation's business and industry. World War I and World War II had pushed the demand for coal to new levels during a time when the United States was emerging as a leader among nations.

After World War II, however, plentiful supplies of petroleum and natural gas were discovered, and, by 1952, coal was no longer America's top energy source. Homes that used to be heated by coal switched to oil and gas. Trains that used to be powered by coal used diesel fuel instead. State and federal regulations of the 1960's and 70's concerning mining and environmental issues also reduced coal production.

Coal's decline was finally halted by the 1973 oil embargo and a growing



Geological processes over vast spans of time compressed and altered the decaying plants, increasing the percentage of carbon and eventually producing coal.

demand for electricity. Since the early 1970's, coal production has steadily increased, reaching record highs again. Today coal provides some 30 percent of the nation's energy needs. It's major use today is for electricity production.

Types of Coal

Not all coal is alike. Coal is classified into three main ranks or kinds: lignite, bituminous, and anthracite. The classifications are based on the amount of carbon, oxygen, and hydrogen present in the coal. Generally, the more carbon a type of coal has, the more heat energy it contains.

Lignite, is the lowest rank of coal, with a heating value of just 4,000 to 8,300 **British thermal units (Btu)** per pound. *(Note: One Btu is the heat needed to raise the temperature of one pound of water one degree Fahrenheit. A burning kitchen match releases about one Btu.)* Lignite is crumbly and has a high moisture content. Most of the lignite mined in the United States comes from Texas. Lignite is mainly used to produce electricity. It is about 25 to 35 percent carbon.

Bituminous coal, or soft coal as it is sometimes called, was formed by added heat and pressure on lignite. Made up of many tiny layers, bituminous coal looks smooth and sometimes shiny. It is by far the most abundant type of coal found in the United States, accounting for 90 percent of all the coal mined. It can have two to three times the heating value of lignite, containing 10,500 to 15,500 Btu per pound. Bituminous coal is used to generate electricity, and it is an important energy source for the steel, iron, cement, automobile, textile, and plastic industries. It is about 45 to 86 percent carbon. **Subbituminous coal** contains less heating value than bituminous coal (8,300 to 11,500 Btu per pound) and more moisture. It is about 35 to 45 percent carbon.

Anthracite, or hard coal, was created where additional pressure combined with the very high temperature inside the earth. It is deep black and looks almost metallic due to its glossy surface. It is found primarily in the 11 northeastern counties of Pennsylvania and therefore constitutes a small share of the domestic coal market. Like bituminous coal, anthracite coal is a big energy producer, containing nearly 15,000 Btu per pound. It is about 86 to 97 percent carbon.

Coal Mining: Surface and Underground

There are two commonly used methods to remove coal from the ground: surface mining and underground mining.

Surface mining is used when a coal seam is relatively close to the surface, usually within 200 feet. The first step in surface mining is to remove and store the soil and rock covering the coal (the "overburden"). A variety of heavy equipment, such as draglines, power shovels, bulldozers, and front-end loaders, is used to expose the coal seam for mining.

After surface mining, the overburden must be replaced, graded, recovered with topsoil, fertilized, and seeded to restore the biological balance and to prevent erosion. The land is then used for croplands, wildlife habitats, recreation, or as sites for commercial development.

Although only about 32 percent of the nation's coal can be extracted by surface mining, some 60 percent of all U.S. coal is mined using this method today. Why? The answer is simple. Surface mining is simply much cheaper than underground mining.

Underground mining is used when the coal seam is buried several hundred feet below the surface. In underground mining, workers and machinery go down a vertical "shaft" or a slanted tunnel called a "slope" to remove the coal. Mine shafts may sink as much as 2,000 feet deep.

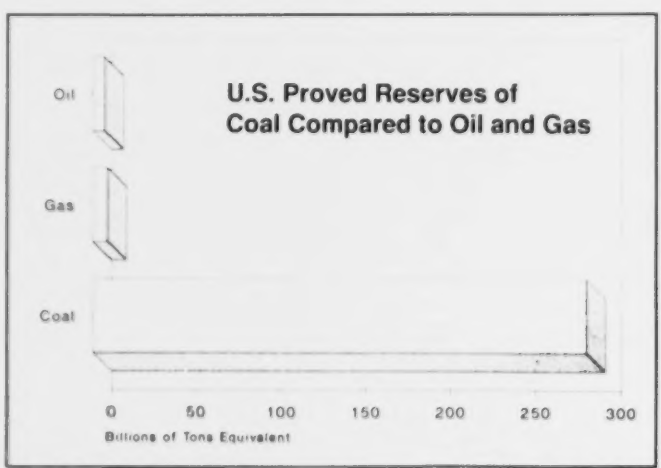
One underground mining method is called **room-and-pillar mining**. With this method, much of the coal must be left behind to support the mine's roofs and walls. Sometimes as much as half the coal is left behind in large column formations to keep the mine from collapsing.

A more efficient and safer underground mining method, called **longwall mining**, uses a specially shielded machine which allows a mined-out area to collapse in a controlled manner. This method is called "longwall" mining because huge blocks of coal up to several hundred feet wide can be removed. It is important to remove as much coal as possible from underground mines because the bulk of U.S. coal, 68 percent, is found in underground formations.

Coal Reserves and Coal Production

When scientists estimate how much coal, petroleum, natural gas, etc. there is in the United States, they use the term **reserves**. *Known coal reserves* are deposits of coal in the ground waiting to be mined. Experts estimate that the United States has about 244 billion tons of coal reserves. That's the energy equivalent of 5,422 quads. At current rates of consumption, the United States has about 300 years of coal reserves. This vast amount of coal makes the United States the world leader in known coal reserves.

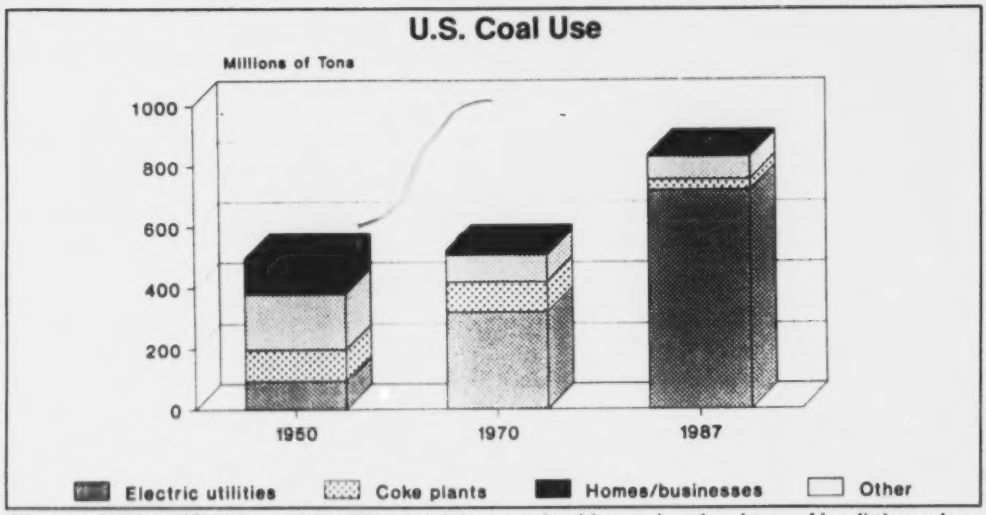
Where is all this coal located? Coal deposits can be found in 38 of the 50 states. States east of the Mississippi River contain about 45 percent of the known coal reserves while western states and Alaska contain about 55 percent. Montana has the most coal – about 120 billion mineable tons. Other top coal states in order of known reserves are: Illinois, Wyoming, Kentucky, West Vir-



The United States has large proven reserves of coal, especially when compared to proven reserves of oil and natural gas. Graphic courtesy of U.S. Dept. of Energy.

ginia, Pennsylvania, Ohio, Colorado, Texas, and Indiana. Western coal generally contains less sulfur (which is good for the air when coal is burned) than eastern coal, but not always.

Coal *production* refers to the amount of coal mined or taken out of the ground. Where does mining take place in the United States? Although coal is mined in 27 states, more coal is mined in eastern states, especially coal that is taken from underground mines, than in the western states. However, the West's share of total coal production has increased steadily since 1968 when it provided just five percent of U.S. production. Today the West provides 36 percent of the nation's total production.



Most coal today (85%) is used to make electricity; another big user is coke plants. Very little coal, on the other hand, is used to heat homes and businesses. Graphic courtesy of U.S. Dept. of Energy.

Total U.S. production of coal reached 958 million tons in 1988, a historic high. The leading coal producing state in 1989 was Wyoming followed by Kentucky, West Virginia, Pennsylvania, and Illinois.

The federal government is by far the largest owner of the nation's coal. In the west, the federal government owns 60 percent of the coal and indirectly controls another 20 percent. Coal companies must lease the land from the federal government in order to mine this coal.

Processing and Transporting Coal

Coal is cleaned and processed after mining to remove dirt, rock, ash, sulfur, and other loose impurities. A processing plant, or preparation plant as it is often called, is usually located right at a mine site. A conveyor belt takes the coal from the mine into the preparation plant where the coal is washed. Removing all the impurities increases the heating value of coal.

After the coal is mined and processed, it is ready to go to market. Transportation is a very important consideration in coal's competitiveness with other fuels since transportation costs can sometimes exceed the cost of mining the coal.

Most coal today (about 57 percent) moves by railroad for at least part of its journey to market. But the cheapest transportation method is water. Moving coal on river barges is an important alternative to railroad delivery. Coal can also be moved by trucks and conveyors if the coal mine is close to the user. In one location, coal is even crushed and mixed with water for transport by pipeline. Ideally, electric power plants are located at mine sites to minimize transportation costs.

How Coal Is Used

Most coal in the United States, about 85 percent, is used by electric power plants to generate electricity. In fact, 57 percent of all the electricity generated in the U.S. comes from coal. (Other energy sources used to generate electricity include natural gas, oil, and nuclear power.)

Another major consumer of coal is the iron and steel industry which uses coke ovens to melt iron ore. **Coke** is an almost pure carbon residue of coal and is used as a fuel in making metals. The United States has the finest coking coals in the world. These coals are shipped around the world for use in coke ovens. In fact, foreign countries import ten percent of all the coal produced in the U.S. The five biggest foreign markets for U.S. coal are Canada, Japan, Italy, Belgium, and Brazil.

Although coal used to be a major heating fuel for American homes and businesses, this is no longer true. In fact, less than one percent of the coal produced in the U.S. today is used for heating. Coal furnaces have largely been replaced by gas or electric furnaces.

Coal and the Environment

When coal became an important energy source for American industry over a century ago, concern for the environment was not at the forefront of public attention. For years, smokestacks from electrical and industrial plants emitted pollution into the air. Coal mining left some land areas barren and destroyed. Automobiles, coming on strong after World War II, contributed noxious gases to the air. Eventually, as the effects of pollution became more and more noticeable, Americans became concerned about balancing the needs of industry with protecting the environment.

Federal laws passed in the 1960's and 70's, namely the Clean Air Act and the Clean Water Act, required industries to reduce pollutants released in the air and the water. Laws were also passed that required coal mine companies to reclaim the land destroyed by strip mining. Since the passage of these laws a decade or so ago, a lot of progress has been made toward cleaning up the environment.

Today, removing *organic sulfur*, which is chemically bound to coal, remains the coal industry's most troublesome problem. All fossil fuels, such as coal,

petroleum, and natural gas, contain sulfur. When these fuels are burned, the organic sulfur is released into the air where it combines with oxygen to form sulfur dioxide. Sulfur dioxide is an invisible gas that has been shown to have adverse effects on the quality of air we breathe. It also contributes to **acid rain**, an environmental problem which adversely affects wildlife (especially fish) and forests.

However, the coal industry has made much progress in removing organic sulfur from coal. One method removes the sulfur by use of "scrubbers." Scrubbers are installed at coal-fired electric and industrial plants where a water and limestone mixture reacts with sulfur dioxide to form a sludge. Scrubbers eliminate up to 90 percent of the sulfur dioxide, but they are very expensive to build.

The coal industry is also concerned about the carbon that is released when coal is burned. Carbon emitted from electrical and industrial plants reacts with the air to form carbon dioxide. When carbon dioxide and other gases, such as those emitted from automobiles and aerosol cans, accumulate in the earth's atmosphere, they form a shield which allows the sun's light and heat in, but doesn't let it out. This condition is called the **greenhouse effect**.

Scientists and others are concerned about the greenhouse effect because it could cause a change in the earth's climate. Some say the earth is already experiencing a warming trend due to the greenhouse effect; others are not so sure yet. While warmer weather might be appreciated by some in northern climates, it could cause drought in some areas of the world (the American grain belt, for example) and the erosion of ocean coasts due to rising sea levels in all areas.

The coal industry is currently researching ways to lower carbon dioxide emissions. But a wholescale approach will be needed to stop the greenhouse effect. This approach must look not only at the burning of fossil fuels as a problem, but also at automobile emissions, the deforestation of the world's forests, and several other possible contributors.

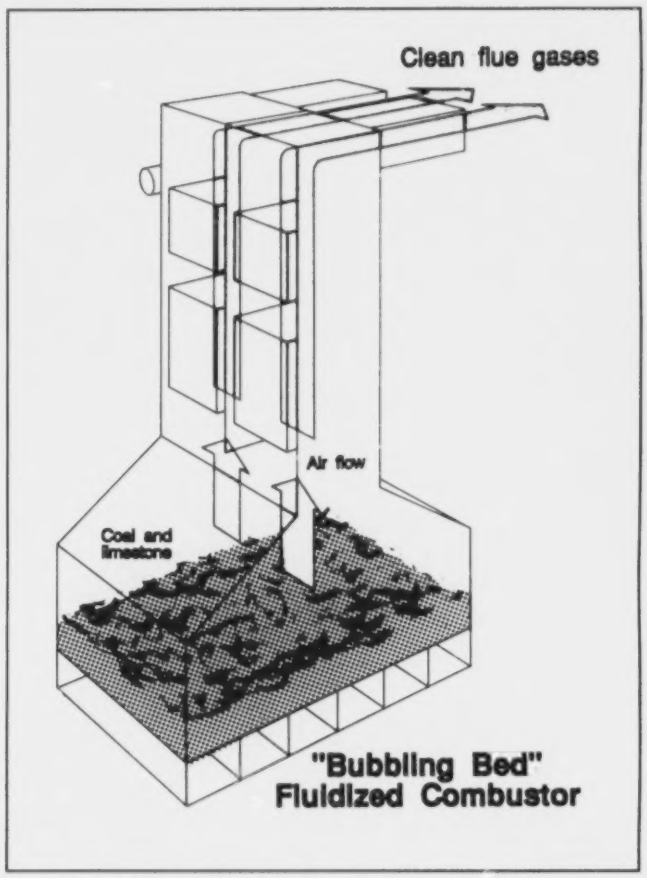
Clean Coal Technologies

Coal is the United States' most plentiful and cheapest fossil fuel. Unfortunately, it's also the nation's dirtiest fuel. Coal can help the U.S. achieve energy security and turn around its trade deficit *if* we can use coal in a such a way that it won't endanger our environment.

The Clean Coal Technology Program is a government and industry funded effort to implement a new generation of clean coal technologies. Begun in 1986 in an effort to resolve U.S. and Canadian concern over acid rain, clean coal technologies refer to several techniques that remove sulfer and nitrogen oxides before, during, or after coal is burned, or to those techniques which bypass burning processes altogether by converting coal to a gas or liquid fuel.

One technique that cleans coal as it burns is a **fluidized bed combustor**. In this type of combustor, crushed coal is mixed with limestone and suspended on jets of air inside a boiler. The coal mixture floats in the boiler much like a boiling liquid. The limestone acts like a sponge by capturing 90 percent of the organic sulfur that is released when the coal is burned. The bubbling motion of the coal also enhances the burning process. Combustion temperatures can be held to around 1,500 degrees F., about half that of a conventional boiler. And since this temperature is below the threshhold where nitrogen pollutants form, a fluidized bed combustor keeps both sulfur and nitrogen oxides in check.

Another kind of clean air technology bypasses the conventional coal burning process altogether by converting coal into a gas. A **combined cycle system** uses a combination of gasified coal and steam to generate electricity. Sulfur, nitrogen compounds, and particulates are removed before the fuel is burned, making it as clean as natural gas.



A "bubbling" fluidized bed combustor is one type of clean coal technology. In this combustor, coal particles tumble in a turbulent fashion, taking on some of the characteristics of a boiling liquid. Illustration courtesy of U.S. Dept. of Energy.

Printed on recycled paper

Energy Fact Sheet: Geothermal

1989 Facts At a Glance

Classification: *Renewable*

Percent of U.S. energy production: *0.4%*

Percent of U.S. energy consumption: *0.43%*

Major Use: *Electricity*

What Is Geothermal Energy?

Geothermal energy is a renewable source of energy that comes from the heat within the earth. The word "geothermal" comes from the Greek words *geo*, meaning "earth," and *therme*, meaning "heat." People around the world use geothermal energy to produce electricity, heat buildings and greenhouses, and for other purposes.

Geothermal energy is generated in the earth's **core**, almost 4,000 miles beneath the earth's surface. The double-layered core is made up of very hot **magma** (molten iron) surrounding a solid iron center. Estimates of the temperature of the core range from 5,000 to 11,000 degrees Fahrenheit (°F). Heat is continuously regenerated deep within the earth by radioactive decay.

Surrounding the earth's core is the **mantle**, thought to be partly rock and partly magma. The mantle is about 1,800 miles thick. The outermost layer of the earth, the insulating **crust**, is not one continuous sheet of rock but is broken into several pieces called **plates**. These slabs of continents and ocean floor drift apart and push against each another at the rate of about one inch per year in a process called **plate tectonics** or **continental drift**.

Magma may come quite close to the surface where the crust has been thinned, faulted, or fractured by plate tectonics. When this near-surface heat is transferred to water, a usable form of geothermal energy is created.

History of Geothermal Energy

We know that many ancient peoples, including the Romans, Chinese, and Native American Indians, used hot mineral springs that flow naturally from the earth for bathing, cooking, and heating. Hot springs and hot water piped from wells are now used world-wide in spas, for heating buildings, and for agricultural and industrial uses. Many people believe hot mineral springs have therapeutic value.

The use of geothermal energy to produce electricity is a relatively new industry. It was first initiated by a group of Italians who built an electric generator at Lardarello in 1904 using the natural steam erupting from the earth.

The first attempt to develop geothermal power in the United States came in 1922 at the Geysers steam field in northern California. But the pipes and turbines of the day could not stand up to the abrasion and corrosion of the particles and impurities that were in the steam.

Later, a small but successful hydrothermal plant opened at the Geysers in 1960. Today, 28 plants are operating there.

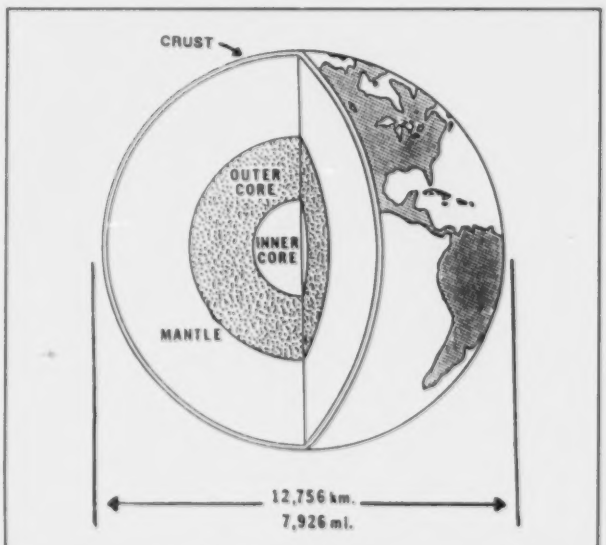
Electricity is now produced from geothermal energy in 21 countries including the United States.

Where Is Geothermal Energy Found?

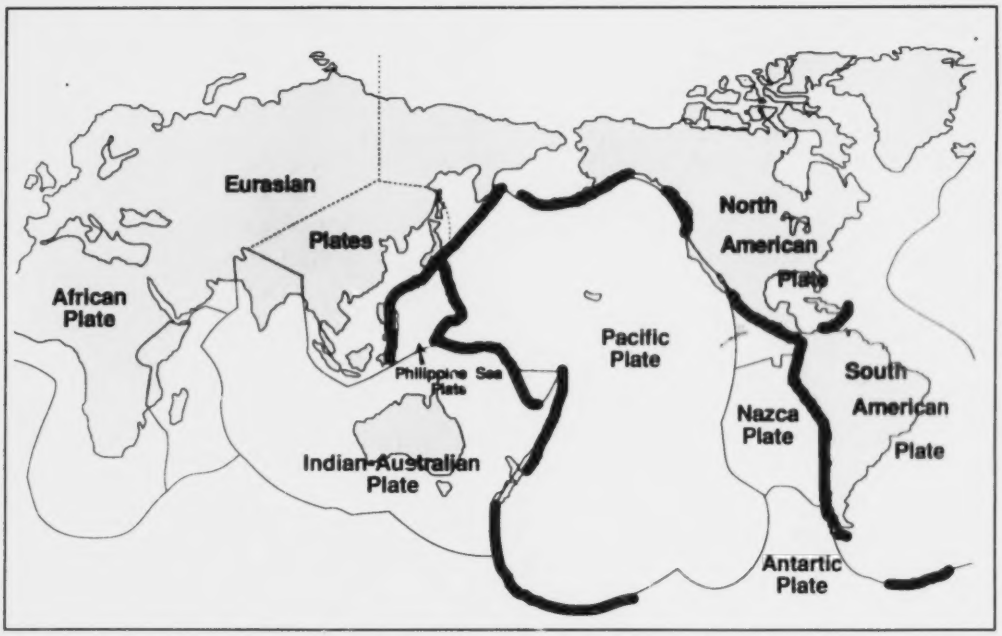
Globally, strong geothermal activity occurs in what is known as the "Ring of Fire" that follows the Pacific rim – an area bounded by Japan, the Philippines, the Aleutian Islands, North America, Central America, and South America. Europe, Asia, and Africa also have active geothermal resources, usually along major plate boundaries where earthquakes and volcanoes are concentrated.

The best known geothermal energy sources are located in Italy, Japan, Mexico, the United States, New Zealand, Iceland, Kenya, Indonesia, and the Philippines. Recent studies suggest that moderately hot geothermal resources in the United States also exist in the Dakotas, along the Atlantic coast, and in Arkansas and Texas and could prove quite successful.

Some of the visible features of geothermal energy are volcanoes, hot springs, geysers, and fumaroles. Much



The Earth, seen in cross section: *The earth has a concentric (layered) structure made up of an inner core, outer core, mantle, and crust. Illustration courtesy of GEO.*



The Ring of Fire: *This area circling the Pacific Ocean has an abundance of earthquakes and volcanic and geothermal activity.*

geothermal energy, however, is deep underground with no surface indicators. Geologists use many methods to find geothermal resources including studying aerial photographs, geological mapping, analyzing the chemistry of local water sources and the concentration of metals in the soil, and measuring variations in gravity and magnetic fields. To confirm geothermal resources, however, wells must be drilled to measure temperatures.

Geothermal Energy Today: Hydrothermal Resources

There are four main kinds of geothermal resources: hydrothermal, geopressured, hot dry rock, and magma. Today hydrothermal resources are the kind in wide use. The other three resources are still in the infant stages of development.

Hydrothermal resources have the common ingredients of water (*hydro*) and heat (*thermal*). These geothermal reservoirs of steam or hot water occur naturally where magma comes close enough to the surface to heat groundwater trapped in fractured or porous rocks or where water circulates at great depth along faults. Hydrothermal resources are used for different energy purposes depending on their temperature and how deep they are.

Low Temperature: Direct Use

At temperatures around 50 °F and up, hydrothermal resources can be used directly in spas or to heat buildings, grow crops, warm fish ponds, or for other uses. Hydrothermal resources suitable for direct use occur throughout the United States and in almost every country in the world. For example, most of the population of Iceland and over 500,000 people in France use geothermal heat for their public buildings, schools, and homes. In the United States, geothermal heat pumps (or heat exchangers) are used in 45 states to heat and cool homes and buildings. Heating of entire districts with geothermal energy is also done in Idaho, Oregon, Nevada, and other states. At higher temperatures, heat from geothermal resources is used to dry ceramics, lumber, fruits, vegetables, and other products.

High Temperature: Producing Electricity

Hydrothermal resources at temperatures of about 220 °F and up can be used to generate electricity. Most generation of electricity comes from reservoirs with temperatures from 300 to 700 °F, but geothermal reservoirs can reach nearly 1,000 °F. Two main types of hydrothermal resources are used to generate electricity – dry steam (*vapor*-dominated) reservoirs and hot water (*liquid*-dominated) reservoirs.

Dry steam reservoirs are rare but highly efficient at producing electricity. The Geysers in California is the largest and best known dry steam reservoir. Here, steam is obtained by drilling wells from 7,000 to 10,000 feet deep. In a vapor-dominated reservoir, the natural steam is piped directly from a geothermal well to power a turbine generator. The spent steam (condensed water) can be used in the plant's cooling system and injected back into the periphery of the reservoir to maintain water and pressure levels.

Hot water geothermal reservoirs are the most common type. In a liquid-dominated reservoir, the hot water has not vaporized into steam because the reservoir is saturated with water and is under pressure. To generate electricity, the hot water is piped from geothermal wells to one or more separators where the pressure is lowered and the water *flashes* into steam. The steam then propels a turbine generator to produce electricity. The steam is cooled and condensed and either used in the plant's cooling system or injected back into the periphery of the geothermal reservoir.

A **binary cycle** power plant is used when the water in a liquid-dominated reservoir isn't hot enough to allow flashing of steam. In a binary plant, the lower-temperature hot water is used to heat a type of gas that expands when warmed. The turbine is powered from the expanded, pressurized gas. The gas is cooled, condensed back to a liquid, and recycled back to be heated over and over again. Electricity can be produced in binary plants from water at temperatures as low as 220 °F, but it is probably not economical at temperatures less than 275 ° F.

In all these power plant types, the heat remaining in the produced water and condensate can be put to a direct use before injection back into the reservoir. This repetitive use of the heat from the same hot water is called **cascading**.

Tomorrow's Geothermal Resources

The other three kinds of geothermal resources – geopressured, hot dry rock, and magma – are often called "near-future" geothermal resources because scientists from the U.S. Department of Energy are studying ways to develop these for electricity production.

Geopressured resources *are reservoirs of hot water and natrual gas (primarily methane) locked in deep sedimentary rocks and under great pressure from the overlying sediments. Research is underway to find ways to use the heat and pressure to produce electricity and ways to reclaim the gases. In the United States, geopressured resources occur along the Texas and Louisiana coasts. Similar resources occur in Hungary and France.*

Hot dry rock *geothermal resources underlie much of the world's surface. The United States is especially rich in hot dry rock resources. A conservative estimate is that the resource base of hot dry rock in the U.S. far exceeds total worldwide fossil fuel resources. Using hot dry rock to produce electricity requires drilling holes deep into the rocks, pumping in cold water at high pressure to fracture the rocks, and then accessing the heated water and steam from an adjacent well to drive a generator. The water can be used repeatedly, and there are no emissions to the air. This process has been successfully demonstrated by an internationally funded research project in New Mexico. Millions of dollars are being invested to study the huge potential of hot dry rock energy in the U.S., the United Kingdom, Japan, Germany, France, and the Soviet Union.*

Magma *geothermal energy has been called the ultimate energy source. Power from magma would use a process similar to hot dry rock – water is injected directly into the magma, cooling and hardening the rock around the well. The steam is pumped out through a pipe in the well and used to run a power plant.*

Geothermal Reserves

Reserves are energy resources that are currently economical to develop given today's prices and conditions. Geothermal energy comprises four percent of the total U.S. energy reserves, an amount exceeded only by biomass (5 percent) and coal (83 percent). Because energy sources are counted as reserves only when they are economical to develop, geothermal reserves increase as the price of oil or gas increases. Improvements in technology can also increase the economic competitiveness, and thus, the reserves of geothermal energy.

Geothermal energy is considered a renewable energy source because the water is replenished by rainfall and the heat is continuously regenerated by the earth. We can't use up geothermal energy like we can fossil fuels. Future generations will still have geothermal energy.

Geothermal Energy Production

From 1978 through 1985, the installed capacity of geothermal power plants in the United States doubled, with 96 percent of the production being from the Geysers dry steam field in northern California. From 1985 through 1989, geothermal capacity doubled again But this time, 60 percent of the new capacity came from new hot water reservoirs in 17 locations in four states – California, Nevada, Utah, and Hawaii.

Today, the total installed capacity of geothermal power plants in the United States is 2,800 megawatts (MW), the energy equivalent of two to three nuclear power plants. (There are currently 109 nuclear plants operating in the United States.) The 64 geothermal power plants in the United States today range in size from a few hundred kilowatts to more than 130 megawatts.

In 1989, geothermal energy produced 11 billion kilo-watt hours of electricity or about 1/2 of one percent of the electricity used in this country. This small but important contribution was enough to serve the electrical energy needs of over three million households. Currently, California gets six percent of its electricity from geothermal energy, more than any other state.

Geothermal energy production is expected to grow in the coming decade. In the U.S., at least 400 MW more capacity is planned within five years and geothermal advocates estimate that geothermal energy could provide 15 percent of the electrical capacity of the western U.S. by the turn of the century.

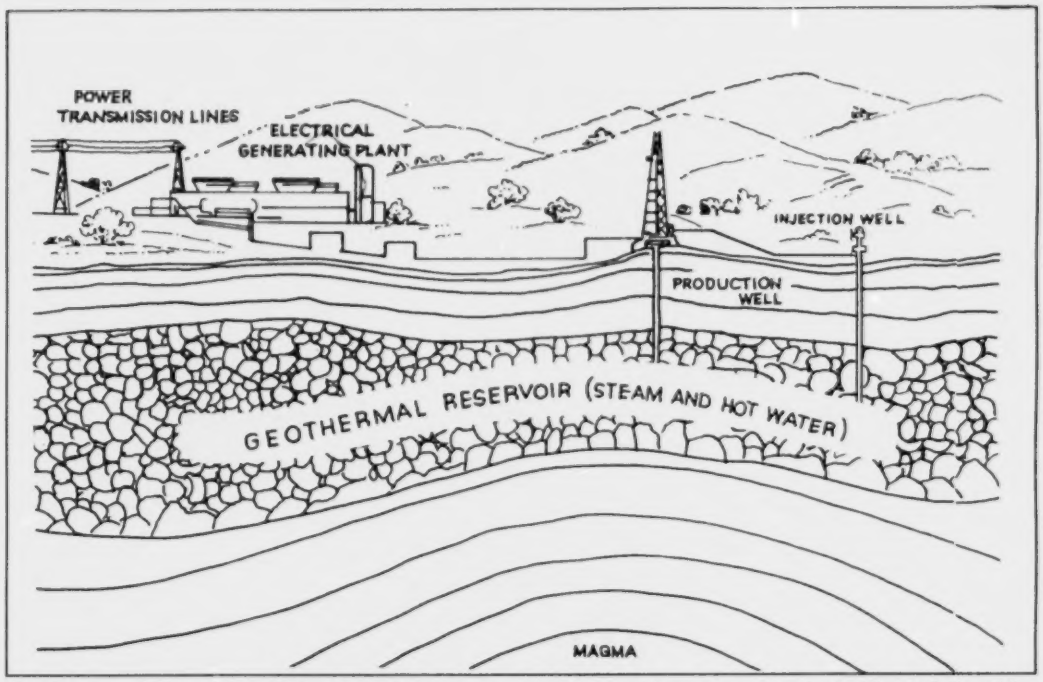
Economics of Geothermal Energy

Geothermal resources suitable for direct use occur throughout the U.S. and the world and cost less to use than fossil fuels.

There are many high-temperature geothermal resource areas in the western United States. Illustration courtesy of GEO.

Geothermal power plants compete successfully in the marketplace with other sources of electricity. It costs about 4.5 to 7 cents per kwh to produce electricity from hydrothermal systems. In comparison, new coal-fired plants produce electricity at about 6 to 7 cents per kwh.

Initial construction costs for geothermal power plants are high because the fuel source (geothermal wells) and the power plant must be constructed at the same time. But the cost of producing electricity over time is lower because the price and availability of the fuel is stable and predictable. The fuel does not have to be imported or transported to the power plant. The power plant literally sits on top of its fuel source.



Production of Electricity: *Hydrothermal reservoirs are saturated with water, replenished with rainfall and further sustained by injection of geothermal water back into the reservoirs. Illustration courtesy of GEO.*

Geothermal power plants are also excellent sources of **baseload** power. They run reliably over 90 percent of the time compared to 63 to 80 percent of the time for conventional power plants. Baseload geothermal plants sell electricity all the time, not only during peak-use times when the demand for electricity is high.

Until recently, utilities were required to buy the least-cost electricity, without regard to environmental impacts. Federal and state energy and environmental agencies are studying ways to give preference to nonpolluting energy sources such as geothermal energy.

Geothermal Energy and the Environment

Geothermal energy is a renewable energy source which does little damage to the environment compared to conventional energy sources.

Geothermal steam and hot water do contain naturally occurring traces of hydrogen sulfide (a gas that smells like rotten eggs) and other gases and chemicals which can be harmful in high concentrations. But geothermal power plants use "scrubber" systems to clean the air of hydrogen sulfide and the other gases. Sometimes the gases are converted into marketable products, such as liquid fertilizer. Newer geothermal power plants are even able to inject these gases back into the geothermal wells underground.

Geothermal resources do not require the burning of fuels to generate electricity as do fossil fuels. Carbon dioxide (CO_2) and methane are the primary greenhouse gases that cause global warming. Motor vehicles and fossil fuel plants contribute most of these gases. In comparison, geothermal power plants release less than one to four percent of the amount of CO_2 emitted by coal plants.

Emissions of sulfur compounds from motor vehicles and fossil fuel plants are also major contributors to acid rain. Geothermal power plants, on the other hand, emit only about one to three percent of the sulfur compounds that coal and oil-fired power plants do. Well-designed binary cycle power plants have no emissions at all.

Geothermal power plants are compatible with many environments. They have been built in deserts, in the middle of crops, and in mountain forests.

Because it does not significantly harm the environment, geothermal development is often allowed on federal lands. Studies under the National Environmental Policy Act are first made to determine environmental impact before permission is granted. Geothermal features in national parks, such as the geysers and fumaroles in Yellowstone and Lassen National Parks, are protected by law, so geothermal energy is not tapped in these areas.

There is a demand for renewable sources of energy that don't contribute to acid rain and global warming. Because of its environmental advantages, abundance, and reliability, geothermal resources will be providing more and more of our energy needs.

NEED would like to thank the Geothermal Education Office for its assistance in producing this fact sheet.

Energy Fact Sheet: Hydropower

1989 Facts At A Glance

Classification: *Renewable*

Percent of U.S. electricity production: *9.5%*

Percent of U.S. energy consumption: *4%*

Major Use: *Electricity (264 billion kilowatt-hours)*

What Is Hydropower?

Hydropower (from *hydro* meaning water) is a renewable source of energy that is obtained from the movement of water. The fall and flow of water is part of a continuous natural cycle. The sun draws moisture up from the oceans and rivers, and the moisture then condenses into clouds in the atmosphere. This moisture falls as some form of precipitation, replenishing the oceans and rivers, driving the flow of water which is destined by gravity to move from places of higher ground to places of lower ground. The force of moving water can be extremely great as anyone knows who has been white water rafting or even canoeing in a difficult stream.

History of Hydropower

One of the oldest methods of using renewable energy sources is the water wheel. The water wheel picks up flowing water in buckets located around the wheel, and the dead weight of the water causes the wheel to turn. Thus the **kinetic energy** (energy pertaining to motion) of the water is converted into mechanical energy to grind grain, drive sawmills, or pump water.

Water wheels have been in use for centuries; the Greeks used water wheels to grind wheat into flour more than 2000 years ago. In both the United States and Europe, industrial plants in the early 1800's used the water wheel to power machines.

In the latter part of the 19th century, falling water was first put to use to generate electricity. Hydroelectric power plants were built at the sites of waterfalls and dams, the first of which, a plant at Niagara Falls, was built in 1879. In the following decades, many more plants were built. Eventually, they were organized into regional networks. At their height in the early 1940's, hydropower electric plants provided 33 percent of this country's electricity.

By the late 1940's, however, the prime sites for big dams had been developed and fewer large projects were undertaken. Also, inexpensive fossil fuel (coal, oil) plants began to underprice the smaller hydroelectric plants. Not until the oil embargo of 1973 did people show a renewed interest in hydropower.

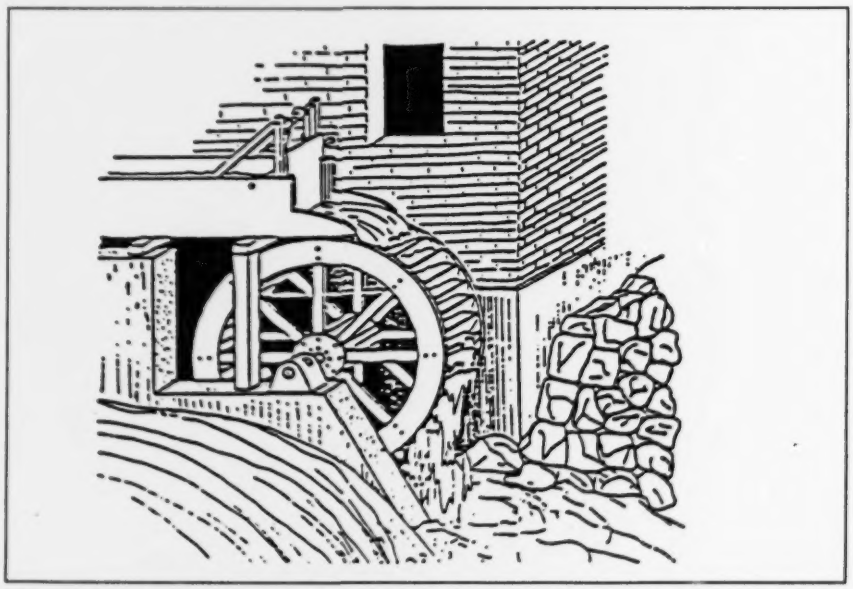
Hydroelectric Power Plants

As people discovered centuries ago, the flow of water represents a huge supply of kinetic energy which can be tapped in order to do work. While water wheels are useful for generating mechanical energy to grind grain or saw wood, they are not practical for generating electricity because of their bulky structures and slow speeds. Instead, hydroelectric plants – like thermal (coal, nuclear) power plants – rely on turbine generators to produce electricity.

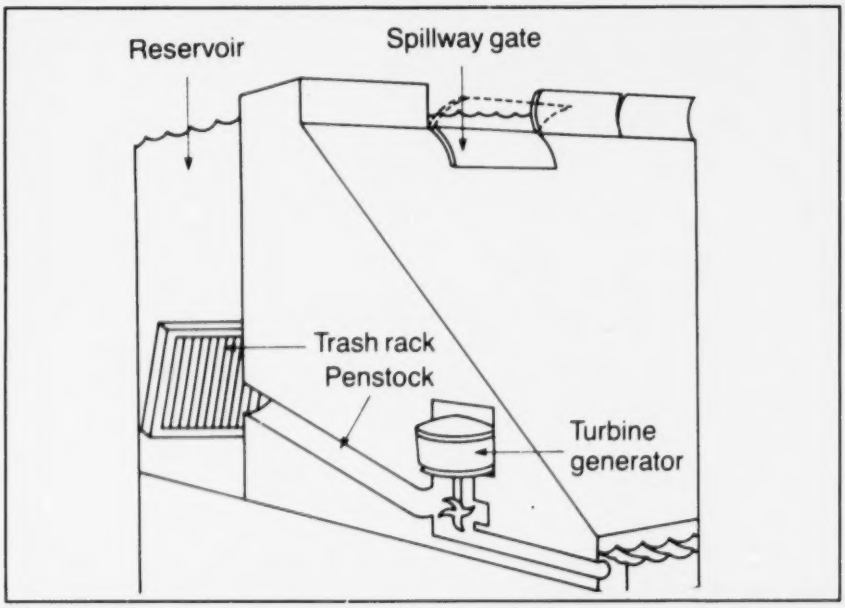
How a Plant Works

Basically, a hydroelectric plant works by directing the flow of water from a dam's **reservoir** (an artificial lake) down a large tube called a **penstock**. At the bottom of the penstock, the fast-moving water spins the blades of a turbine which is connected to a generator to produce electricity. The electricity is then transported via huge transmission lines to a local utility company which distributes it to customers.

How much electricity can be generated at a hydroelectric plant is determined by two factors: head and flow. **Head** is the distance from the



A water wheel uses buckets to pick up water. The weight of the water then causes the wheel to turn.



Water rushing down through **penstocks** *turns a* **turbine generator** *which produces electricity.* **Trash racks** *prevent reservoir debris from entering the penstocks and fouling the turbines.* **Spillway gates** *release excess water from the reservoir during periods of heavy rainfall. Illustration courtesy Electric Power Research Institute.*

highest level of the dammed water (above the drop) to the point where it goes through the power-producing turbine (below the drop). It is the falling action of the water which is converted into useful energy. In general, hydroelectric power plants must have a head of water of at least 20 feet.

Flow refers to the rate at which water moves through the system. Generally, a high-head plant needs less water volume than a low-head plant to produce the same amount of electricity. High flows depend upon large volumes of water and therefore require larger equipment to make use of the resource.

The ability to store water is one of the biggest advantages of a hydroelectric plant. Water can be stored and released as the demand for electricity increases or decreases, or to adjust to periods of heavy rainfall. During the night, when people use less electricity, water can be held back in a plant's reservoirs. Then, during the day when electricity demand is higher, water can flow through a plant to generate electricity. Storage also makes it possible to save water from winter rains for summer generating power or to save water from wet years for generating electricity during dry years.

Dams

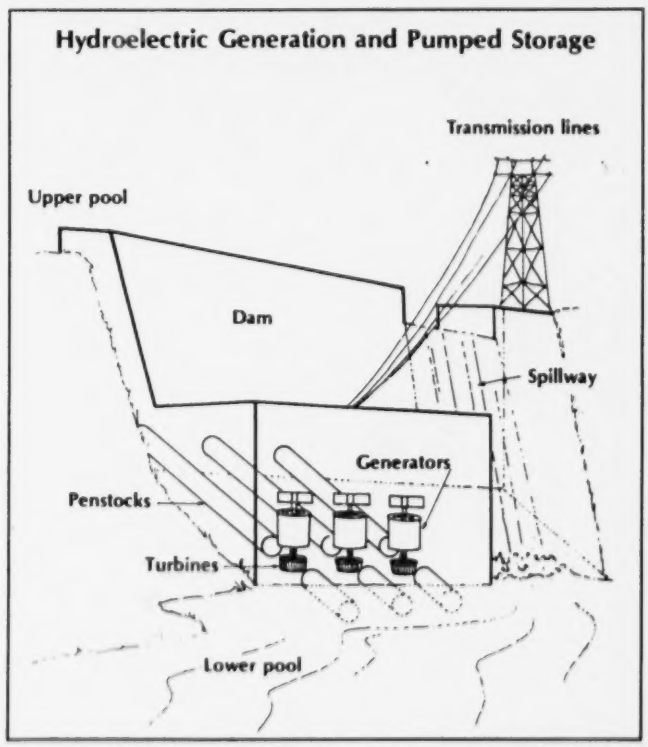
If a natural waterfall cannot be found to serve as host to a hydroelectric power plant, the usual method is then to dam up rivers where the terrain will produce a reservoir – an artifical lake used for storing water. There are some 63,000 dams in the United States, but only three percent of these dams have power-generating facilities. Most dams are simply built for flood control and irrigation rather than for electric power generation.

At a hydroelectric plant, a dam serves two purposes. First, a dam increases the head or elevation of a waterfall. Second, it controls the flow of water, releasing water when it is needed for electricity production. (Spillway gates serve to release excess water from the reservoir during periods of heavy rainfall.)

Of course, some very small hydroelectric plants do not employ dams at all. Instead, these **"run of the river"** plants depend entirely on a river's constant flow of water to meet power needs.

Pumped Hydro Systems

One of the most important benefits associated with hydroelectric power is its ability to store energy. (The water reservoir formed by a dam is, in effect, stored energy.) In a **pumped hydro system**, a secondary reservoir, called a headpond or upper pool, is constructed above the power plant. When electricity demand is high, water flows down from this reservoir to the plant to produce electricity. The water then flows into a lower reservoir, called the tailpond or lower pool, where it is pumped back to the headpond. The water can then be used again and again to produce electricity. Because a pumped hydro system requires energy to pump the water from the tailpond back to the



A pumped hydro system is the electric industry's only method for storing energy. Illustration courtesy National Hydropower Association.

headpond, the system is usually just used to produce electricity during peak demand periods.

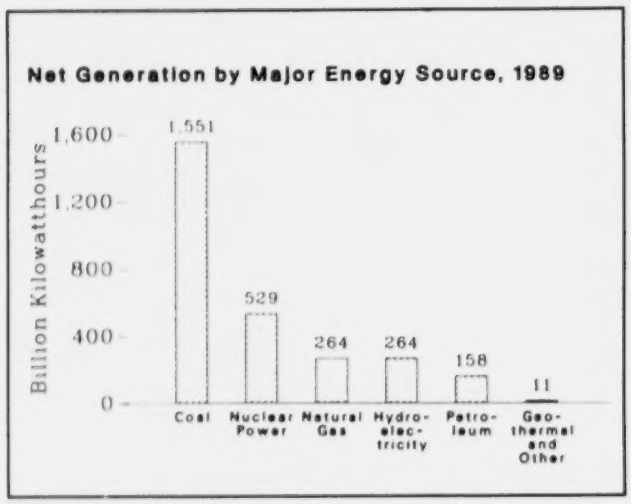
Today, pumped hydro is the *only* energy storage system currently used by American electric utilities to generate electricity during periods of peak demand. Coal and nuclear plants, on the other hand, must turn to expensive gas and oil-fired generators during periods of peak demand because they have no way to store any extra energy they might produce during normal generating periods.

Another benefit of pumped hydro systems is that the electricity is instantly available. A 1,200 megawatt (MW) hydroelectric plant can be at full power within one minute while, in comparison, it takes several hours for a thermal plant to reach full throttle. Pumped hydro systems offer utility companies great flexibility when electricity demands fluctuate and great security if other power plants break down unexpectedly. About 35 pumped hydro systems are operating in the United States today.

Energy storage schemes for the future include underground pumped hydro (UPH) in which the secondary reservoir is located far below the earth's surface. A UPH system will affect the surrounding environment only minimally because the upper reservoir can be small and surface structures few. Although the water in underground reservoirs creates extremely high pressure, many areas in the continental U.S. have deep formations of the hard rock necessary to withstand this force.

Hydropower Production

How much electricity do we get from hydropower today? Quite a bit. Depending on whether the year has been wet or dry, hydroelectric plants produce from eight to 14 percent of the electricity produced in this country, far more than any other renewable energy source. In three states – Idaho, Oregon, and Washington – hydropower supplies over 85 percent of the electricity each year.



In 1989, hydropower tied with natural gas as the nation's third-leading producer of electricity. Graphic courtesy of U.S. Dept. of Energy.

Currently, there are about 90,000 megawatts (MW) of hydroelectric generating capacity in the United States. That's equivalent to the generating capacity of 80 large nuclear power plants. The Federal Energy Regulatory Commission (FERC) estimates that some 60 thousand megawatts of generating capacity remain undeveloped. In addition, *imported* hydropower from Canada is now being sold to some New England utility companies. Individual hydroelectric power plants produce anywhere from one to 6,180 megawatts of electricity per year.

Hydroelectric power plants are reliable sources of **baseload** (electricity that utilities must provide continuously over the course of a year) power. In fact, hydroelectric power plants are more efficient than thermal power plants. They run 85 percent of the time, about twice that of a thermal plant.

Other Sources of Hydropower

There are several different ways to get energy from water. The most common method is building a hydroelectric plant at a waterfall or dam. The energy at a hydroelectric plant is caused by the action of gravity, which pulls falling water toward a turbine generator to produce electricity.

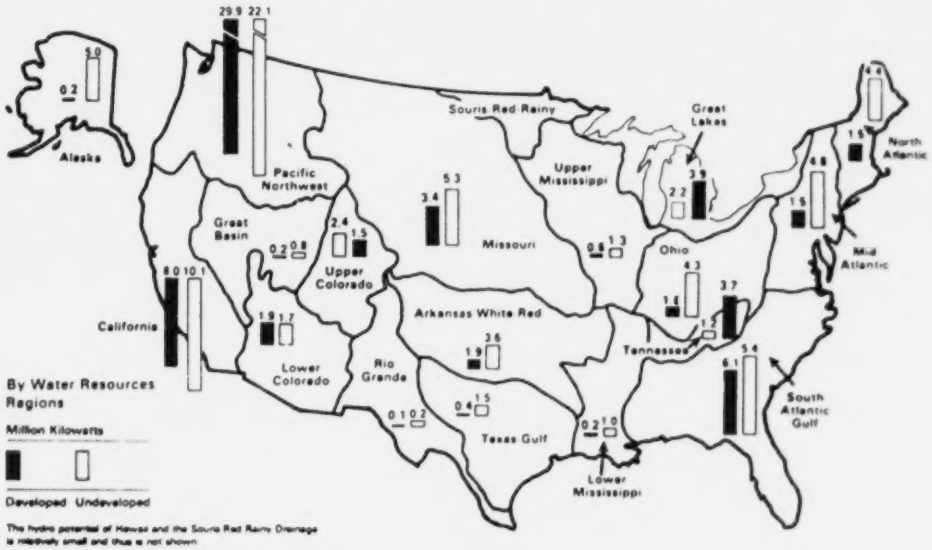
Although uncommon, hydropower can also be obtained from tidal or wave power. **Tidal power** *is caused by the force of the gravitational pull of the sun and moon, especially the moon. The gravitational attraction of the moon for the earth causes the moon to "pull" at the earth. Water reacts dramatically to this pull, rising where it is nearest the moon, and causing a "high tide." The difference between high and low tide can range from a few inches to many feet. At the Sea Anemone Cave in Bar Harbor, Maine, for example, one can take a stroll at low tide to see all the wonders the cave holds, but at high tide the cave is filled with water, making it impossible to walk in!*

To capture the energy from the rise and fall of tides, tidal dams use the incoming (or outgoing) tide to turn turbines to generate electricity. To harness tidal power for electricity production, the difference between high and low tide must be at least 15 feet. Unfortunately, only two locations in the United States meet this requirement.

In fact, few tidal power stations exist in the world. The first was opened at the Rance River in northwestern France in 1962. Canada has built the only other large tidal wave power plant; it's located in the Bay of Fundy. China has built three small tidal wave power plants.

Wave power *is obtained from the waves which form over an ocean or any large body of water. It is caused by the wind driving the water toward shore. The water moves in huge ripples toward land with great energy. Normally, the kinetic energy of the waves is given up as the water dashes against the shore. But a dam could be built to capture this wave power and convert it into electricity. A Norwegian company is currently building the first commercial wave power plant for the Pacific island of Tonga.*

CONVENTIONAL HYDROELECTRIC POWER DEVELOPED AND UNDEVELOPED, JANUARY 1, 1984



Source: Federal Energy Regulatory Commision

In many regions of the country, hydropower resources could be further tapped in order to produce electricity. Illustration courtesy of U.S. Dept. of Energy.

Because the best sites for hydropower dams have already been developed, the development of new large hydroelectric plants is unlikely. But existing plants could be enlarged by adding or refurbishing turbines to provide additional generating capacity. Also, many flood-control dams not equipped for electricity production could be outfitted with generating equipment. By reducing the need for new dams, these options also help save fragile ecosystems from possible disruption or destruction.

Economics of Hydropower

In general, hydropower plants enjoy economic advantages over such thermal power plants as coal and nuclear plants. For one thing, hydropower is the *cheapest* way to generate electricity today. In 1989 it cost less than one cent per kwh to produce electricity at large-scale federal dams while the cost of power from new hydro projects cost from 2.8 to 6.3 cents per kwh. In comparison, it costs new coal plants five to six cents per kwh and nuclear plants 10 cents per kwh. The cost of producing electricity from hydropower is low because, once a dam has been built and the equipment installed, the energy source – flowing water – is free.

Second, the sturdy structures and relatively simple equipment of a hydropower plant are dependable and long-lived, and maintenance costs are low compared to coal or nuclear plants.

The Public Utilities Regulatory Policies Act (PURPA), which Congress passed in 1978, offers financial incentives to hydroelectric plant owners by requiring utility companies to buy electricity from renewable energy source producers at fair prices. The procedure for licensing a dam, however, has become a lengthy and expensive process in which up to 13 state and federal agencies must be consulted and a number of environmental studies undertaken. It takes anywhere from five to seven years to get a license to build a dam.

Hydropower and the Environment

Hydropower does present a few environmental problems. For one, damming rivers causes the destruction and disruption of other natural resources and wildlife. It also affects the water quality by dissolving metals, increasing sediments, changing water temperatures, and lowering the levels of dissolved oxygen. To some degree, these problems can be managed by constructing fish ladders, dredging silt, and carefully regulating plant operations. Of course, these problems are largely avoided at "run of the river" hydro plants.

On the plus side, hydropower's fuel supply (flowing water) is clean and is renewed yearly by snow and rainfall. Unlike fossil fuel plants, hydroelectric plants do not emit any pollutants into the air because they burn no fuel. Hydropower is also the only energy source that offers a whole range of added benefits, e.g., flood control, water supply, irrigation, and recreation (boating, fishing, swimming).

The NEED Project would like to thank the National Hydroelectric Association for its assistance in producing this fact sheet.

Energy Fact Sheet: Natural Gas

What Is Natural Gas?

Natural gas is generally considered a nonrenewable fossil fuel. (There are some renewable sources of natural gas.) Natural gas is called a fossil fuel because most scientists believe that natural gas was formed from the remains of ancient sea plants and animals.

When the plants and tiny sea animals died, they sank to the bottom of the oceans where they were buried by sand and rock. The layers of sand, rock, and plant and animal matter continued to build up until the pressure and heat from the earth turned them into petroleum (oil) and natural gas.

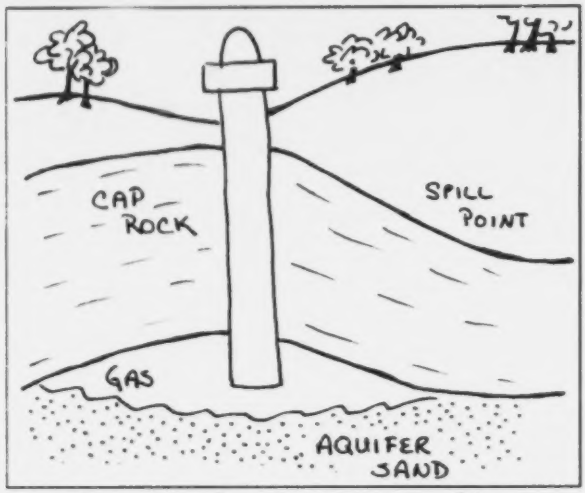
Natural gas is really a mixture of gases trapped in underground rocks much like a wet household sponge traps water. The main ingredient in natural gas is **methane**. By itself, methane has no color, odor, or taste. As a safety measure, natural gas utility companies add an odorant to the gas so that leaking gas can be detected. Natural gas should not be confused with gasoline which is made from petroleum.

History of Natural Gas

People have known about natural gas for thousands of years. The ancient Chinese burned natural gas to evaporate sea water in salt making. Almost 200 years ago the streets of Genoa, Italy, were lighted by natural gas. In 1821, the United States' first successful natural gas well was dug in Fredonia, New York, by William Hart. Today, natural gas supplies about a quarter of all the energy we use in the United States.

Measuring Natural Gas

Gasoline is sold in gallons, coal in pounds, and wood in cords. Natural gas, on the other hand, is sold in cubic feet. But the heat energy that is stored in gasoline, coal, wood, or natural gas can all be measured by one common unit of measure. That common measure is **British thermal units** or **Btu's**. A burning kitchen match releases about one Btu. A cubic foot of gas has about 1,031 Btu.



Over time, natural gas became trapped in porous rock much like a wet household sponge holds water.

The Natural Gas Industry

The natural gas industry is made up of three parts: the natural gas producer; the pipeline company; and the local gas utility.

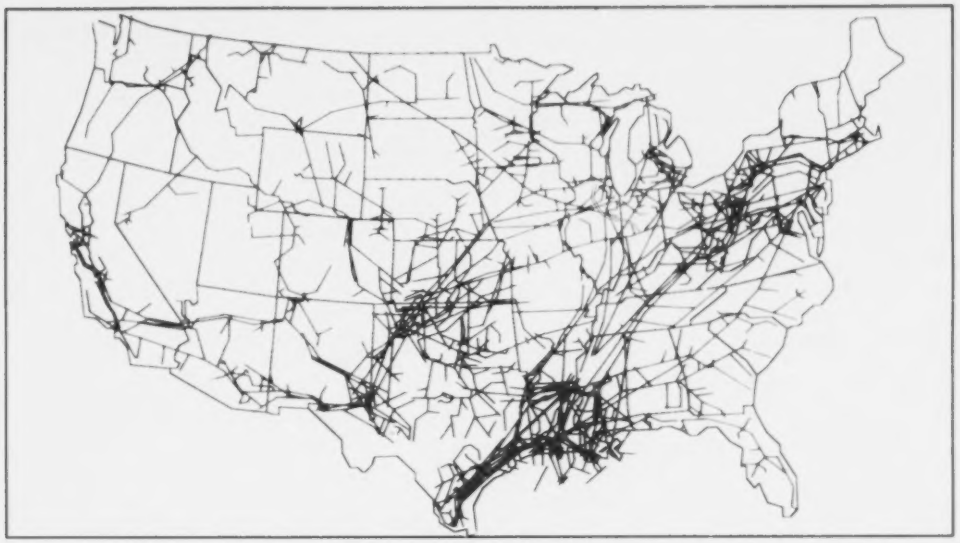
The **natural gas producer** is the company which explores, drills, and takes the natural gas out of the ground. Sometimes wells are drilled only to find that no natural gas is located there. Natural gas wells average over one mile deep!

The **pipeline company** brings the natural gas to the local utility company. Gas is delivered all over the country by way of an underground pipeline system. The gas can travel 500 miles per day.

The **local gas utility** brings the gas from the pipeline company and distributes it to the homes, businesses, and industries in your area. It sends customers a monthly bill which shows how much gas was used during the month and how much it cost.

Natural Gas Resources

Natural gas **resources** are deposits of gas in the ground waiting to be tapped. The United States has large resources of natural gas. States with the largest resources are Texas, Alaska, Oklahoma, Louisiana, and New Mexico. Large resourcess are also located offshore in the Gulf of Mexico and the Mobile Bay. Given today's prices and drilling technology, scientists estimate that the



A huge underground pipeline networks exists to move natural gas to the user. Illustration courtesy of American Gas Association.

United States has about a 50-year supply of natural gas. Another 200-year supply of natural gas could be produced if consumers are willing to pay more for the gas they use.

Who Uses Natural Gas?

Natural gas supplied the United States with about one quarter of its energy needs in 1989. It was the third leading supplier of the nation's energy, after petroleum and coal.

Industry was the biggest user of natural gas. Industry uses it to provide heat to manufacture goods. Industry also uses natural gas as an ingredient in fertilizer, glue, paint, laundry detergents, and other items.

Natural gas is also used to heat homes and businesses. In fact, it is used to heat over half the homes in this country. About 60 million homes use gas for heating, hot water, and cooking.

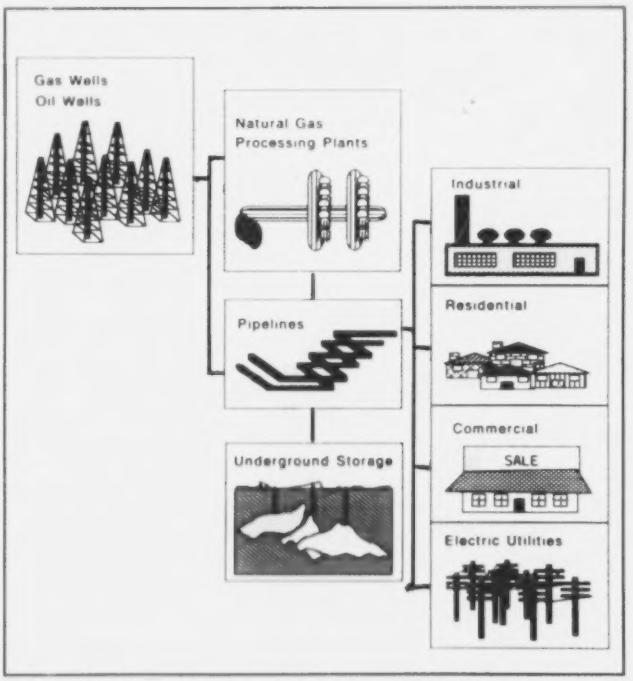
Electric utility companies also use natural gas to produce electricity. Last year, natural gas was used to make about 10 percent of the nation's electricity.

To a small degree, natural gas is even used as a fuel for running automobiles, trucks, and buses!

Natural Gas and the Environment

All the fossil fuels – coal, petroleum, and natural gas – release pollutants into the air when they are burned to provide the energy we need. Three major environmental problems can be traced to the burning of these fossil fuels: acid rain; the greenhouse effect; and urban smog.

The good news is that natural gas is by far the most clean-burning of the fossil fuels. Compared to coal and oil, natural gas releases much less sulfur, carbon, and nitrogen compounds when it's burned and less fly ash. Because natural gas is such a clean source of energy, scientists are looking for new sources of natural gas and new ways to use it.



Natural gas is pumped out of the ground, processed at a plant, and then sold to users. Illustration courtesy of U.S. Dept. of Energy.

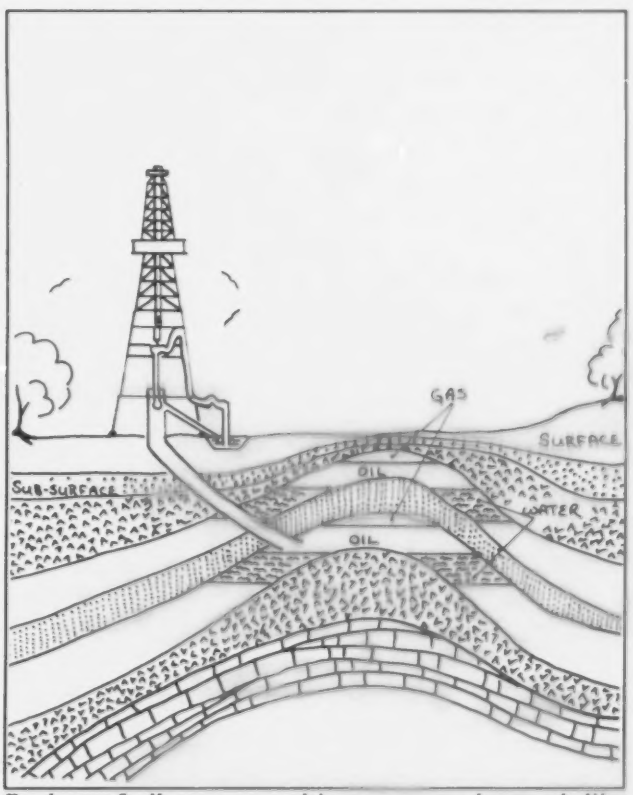
The NEED Project would like to thank the American Gas Association for its assistance in producing this fact sheet.

Energy Fact Sheet: Petroleum

What Is Petroleum?

Petroleum, also called crude oil, is a non-renewable fossil fuel. It's called a fossil fuel because it was formed from the remains of tiny sea plants and animals that died millions of years ago.

When the plants and animals died, they sank to the bottom of the oceans. Here, they were buried by thousands of feet of sand and silt. As the layers increased, they pressed harder and harder on the decayed remains at the bottom. The heat and pressure changed the remains and, eventually, petroleum was formed. Petroleum is locked within rocks almost like water gets trapped in a wet household sponge. When crude oil comes out of the ground, it may be as thin as gasoline or as thick as tar.



Pockets of oil are trapped in porous rocks much like water is trapped in a wet household sponge. Oil companies bring in drilling rigs to remove the oil from the ground. A typical oil well is nearly one mile deep.

History of Oil

People have known about petroleum since ancient times. The ancient Chinese and Egyptians burned oil for light. Before the 1850's, Americans used candles and whale oil to light their homes. When whale oil became scarce, people began skimming the oil which seeped to the surface of ponds and streams. The demand for crude oil increased, and in 1859, Edwin L. Drake drilled the first oil well near Titusville, Pennsylvania.

At first the crude oil was made or **refined** into kerosene which was used for lighting. The other oil products were simply thrown away since there was no use for them. This all changed when Frank and Charles Duryea built the first American gasoline-powered automobile in 1892. Now there was another petroleum product in big demand – gasoline. Today, petroleum provides America with more energy than any other energy source.

Producing Oil

Geologists look at the type of rocks and the way they are arranged deep within the earth to determine whether oil is likely to be found at a location. Still, oil exploration is expensive and often unsuccessful. Out of every 100 wells drilled, only 36 to 40 produce oil.

The average oil well is about one mile deep, but some may sink to more than three and a half miles deep. A pump is used to move the crude oil through a pipe to the surface.

After crude oil comes out of the ground, it is taken to an oil refinery for processing. A refinery separates the petroleum into different fuels and by-products. Gasoline, diesel fuel, and heating oil are three important fuels made from crude oil. Petroleum is also used to make plastics, medicines, cosmetics, paint, rubber, and fertilizers. In all, about 6,000 products are made from petroleum today.

By far, the biggest use of petroleum is for transportation fuels – gasoline, diesel fuel, and jet fuel. About two out of every three barrels of oil is used to keep Americans on the move.

Petroleum Products

Americans consume petroleum products at a rate of 2.6 gallons of oil a day for every man, woman, and child, 365 days a year. But petroleum isn't just used as an automotive fuel. Petroleum "feedstocks" provide us with more than 6,000 products. Here are just some of them.

Ink	*Floor wax*	*Dice*	*Shoe polish*
Heart valves	*Tires*	*Trash bags*	*Food preservatives*
Crayons	*Umbrellas*	*Shampoo*	*Fertilizers*
Parachutes	*Hand lotion*	*Shaving cream*	*Insecticides*
Telephones	*Toothbrushes*	*Cameras*	*Cold cream*
Enamel	*Toothpaste*	*Dentures*	*Detergents*
Transparent tape	*Guitar strings*	*Nail polish*	*Life jackets*
Antiseptics	*Loudspeakers*	*Dashboards*	*Rollerskate wheels*
Purses	*Movie film*	*Luggage*	*Lipstick*
Deodorant	*Aspirin*	*LP records*	*Tennis rackets*
Pantyhose	*Sunglasses*	*Balloons*	*Combs*
Rubbing alcohol	*Glue*	*Paint brushes*	*Safety glass*
Oil filters	*Artificial limbs*	*Footballs*	*Artificial turf*
Pajamas	*Ballpoint pens*	*Dyes*	*Bandages*
Cassettes	*Shower curtains*	*Antihistamines*	*Roofing*
Fishing rods	*Golf balls*	*Skis*	*House paint*
Electrical tape	*Contact lenses*	*Perfumes*	*Credit cards*

Petroleum is produced in 31 of the 50 states. Texas is the leading producer. It is followed by Alaska, Louisiana, California, and Oklahoma – in that order. The largest oil producer in the world is the Soviet Union, followed by the United States, Saudi Arabia, Iran, Iraq, China and Mexico. (However, Saudi Arabia has the most *reserves* of oil still underground.)

Transporting and Storing Oil

Because most oil produced in the United States comes from areas located away from cities and towns, an oil transportation and storage system has been built over the years. Oil can be transported by pipelines, ocean-going supertankers, river barges, trains, and trucks.

Most of the crude oil produced in the United States is transported by pipeline. Petroleum products move through the pipelines at about five miles per hour. At this rate, it takes 15 days to move petroleum products from Houston, Texas to New York City. Today there are about 230,000 miles of petroleum pipelines in the United States.

Huge round storage tanks are used to store petroleum. Sites with many storage tanks are called "tank farms." Gasoline filling stations use *underground* storage tanks to hold their gasoline. Trucks deliver the gasoline to the stations and pump it to the underground tanks.

How Much Oil Do We Use?

Americans use more oil than anyone else in the world. At the rate Americans used petroleum in 1989, the United States has only enough oil to last about ten and half more years. Although it is possible that new oil fields may be discovered, we will still eventually run out of petroleum. And while we are the world's second-leading producer of oil, we still must import 46 percent of our oil from other countries to keep up with Americans' demand. Most of our imported oil comes from Saudi Arabia, Canada, Venezuela, Nigeria, and Mexico – in that order.

Oil and the Environment

Petroleum products – gasoline for cars, medicines, fertilizers, etc. – have helped people all over the world. But there is a flipside. Petroleum products cause air, water, and solid waste pollution. At every stage in bringing oil from the well to the market place, pollution is a concern.

Drilling for oil disturbs fragile land and ocean environments. Transporting oil can endanger wildlife and the environment if it's spilled on rivers and oceans. Processing oil at refineries produces air and water pollution. Leaking storage tanks pollute groundwater. Burning gasoline to fuel our cars causes air pollution. Even disposing of waste oil (for example, the oil drained from the family car) poses pollution problems if it's disposed of carelessly.

The situation is getting better though. Oil companies have cleaned up their refineries. Gasolines and heating oils have been changed to burn cleaner. And oil companies are making sure that the drilling and shipping of oil is done as safely as possible.

Energy Fact Sheet: Propane

1989 Facts At A Glance

Classification: *Nonrenewable*

Percent of U.S. energy consumption: *1.5%*

Percent of U.S. energy production: *2%*

Major Use: *Heating*

What Is Propane?

Propane is a nonrenewable fossil fuel that is extracted from natural gas and petroleum after they are taken out of the ground. Propane is just one of the many hydrocarbon fuels which are included in the **liquefied petroleum (LP) gas** family. But because propane is the type of LP-gas most commonly used in the United States, "propane" and "LP-gas" are often used synonomously.

A propane gas molecule contains three carbon atoms bonded to eight hydrogen atoms, thus its chemical formula, C_3H_8. In a sense, propane has a duel personality. Under normal atmospheric pressure and temperature, propane is a gas. But under moderate pressure and/or a temperature of -43.8 Fahrenheit, propane changes into a liquid. The industry stores propane in its liquid state simply because it is 270 times more compact as a liquid than as a gas. This difference means that a 1,000 gallon tank holding *gaseous* propane would provide a family enough cooking fuel for one week. But a 1,000 gallon tank holding *liquid* propane would provide enough cooking fuel for almost ten years! Liquid propane instantly vaporizes back into a clean-burning gas when released from its storage container to fuel propane gas appliances and equipment.

Like its close cousin, natural gas, propane is colorless and odorless. An odorant is added to propane (as it is to natural gas) to serve as a warning agent for escaping gas. Because it is so easily stored and transported, propane has been nicknamed the "portable gas."

History of Propane

Propane gas wasn't discovered until 1911. Its discovery was a result of an effort to solve a pro-blem with storing gasoline. The problem with gasoline was that it evaporated when stored under normal conditions.

Dr. Walter Snelling, directing a series of experiments for the U.S. Bureau of Mines, discovered that several of the evaporating gases could be changed into liquids (through cooling) and stored at moderate pressure. The most plentiful of these gases was propane. Dr. Snelling developed a way to "bottle" the wet (liquid) gas. One year later, the commercial propane industry began, heating the first American home with propane.

Production and Transportation of Propane

Roughly two-thirds of the propane used in the United States is extracted from raw natural gas. *Raw* natural gas is natural gas that hasn't been cleaned and processed yet. It contains about 90 percent methane, five percent propane, and five percent other gases. The propane is separated from the other gases at a natural gas processing plant.

The remaining one-third of the propane used in this country is extracted from petroleum or, as it is often called, crude oil. Petroleum is separated into its various parts at a processing plant called a refinery – producing gasoline, home heating oil, jet fuel, propane, and other petroleum products.

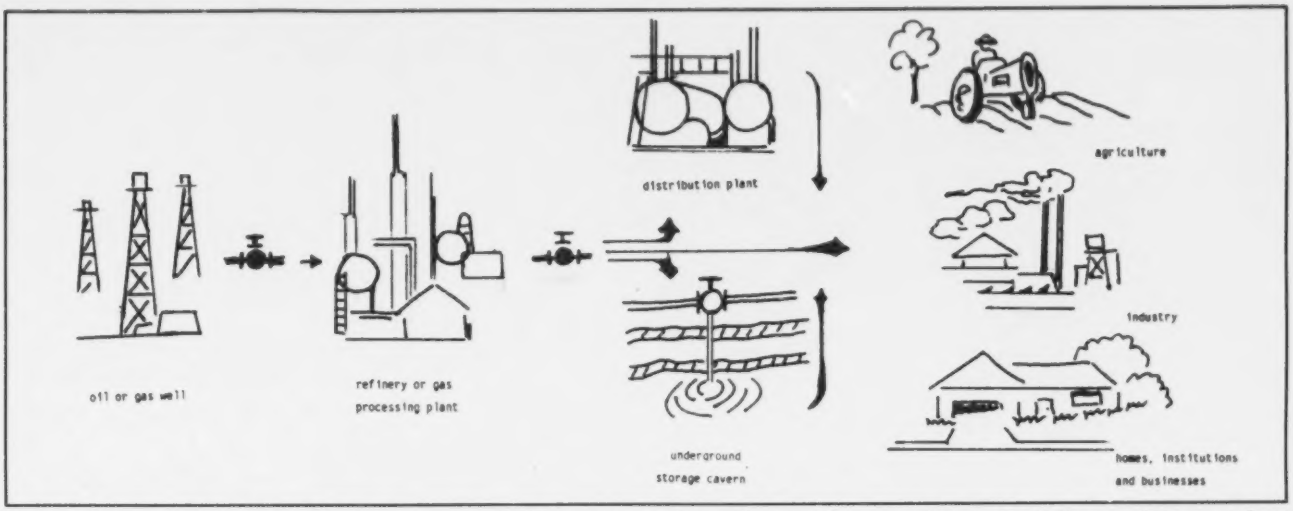
How does propane get from natural gas processing plants or oil refineries to the consumer? Generally, propane is first moved through pipelines to distribution plants across the nation. Distribution plants, which are operated by propane companies, function similarly to warehouses which store merchandise before shipping it to stores and shops. In the U.S., there are over 9,000 distribution plants in operation. Sometimes, especially in summer when demand is lower, propane is stored in large underground storage caverns much like natural gas. Besides pipelines, propane is also transported via railroad tank cars, trucks, barges, and tanker ships.

The local propane dealer supplies homes and businesses with propane in basically two ways. For larger consumers, the dealer sends a truck to fill the consumer's propane tank which may be located either above or below the ground; for smaller consumers, the dealer delivers cylinders of propane. (Consumers who use very little propane – backyard barbecue cooks, for example – must bring their propane cylinders to the dealer to be filled.)

Today's Use of Propane

The United States is the world's leading consumer of propane gas. Propane supplies two percent of our total energy needs and ranks as the seventh most important source of energy in the country today, just after hydroelectric power. Nearly 85 percent of propane supplied to the U.S. market is domestically produced. The other 15 percent is imported from Canada, Venezuela, and Middle Eastern countries. In 1989, Americans used 17.3 billion gallons of propane.

The biggest market for propane is non-metropolitan areas which do not have natural gas service. Today, more than 7.8 million American homes use propane for home heating, hot water, and cooking. High-efficiency propane home appliances include ranges, ovens, space heaters, furnaces, water heaters, clothes dryers, and air-conditioners. Millions of backyard cooks also prefer propane for their barbecue grills because it provides instant heat and does away with the bother and mess of charcoal. Many families also have recreational vehicles equipped with propane-



How propane gets from the well to the consumer: *1) Propane comes from either an oil or nautral gas well. 2) Propane is separated out at an oil refinery or gas processing plant. 3) Next, proapne is sent to a distribution plant or stored in underground caverns. 4) Finally, propane is delivered to the consumer.*

fueled appliances, giving them a portable source of energy for cooking, hot water, refrigeration, and indoor comfort.

In addition, half of America's farms rely on propane to meet their energy needs. Propane has long been used by farmers to dry crops, brood chickens, power tractors, and warm greenhouses.

Business and commercial establishments, from office buildings to grocery stores, from fast-food restaurants to laundromats, use propane for preparing food, heating water, and providing indoor comfort. Resorts, motels, and hotels go even further, using propane to heat whirlpools, saunas, and swimming pools.

Certain industries have found propane well-suited to their special needs. Metal workers benefit from the portability of propane by using small propane tanks to fuel their cutting torches and other equipment. Portable propane heaters give construction and road workers warmth in cold weather. Propane heaters at construction sites are used to dry concrete, plaster, and fuel pitch. Propane also heats asphalt for highway construction and repairs. And because propane is a very low-pollution fuel, fork-lift trucks powered by propane can operate safely inside factories and warehouses.

Propane—A Transportation Fuel Too

Propane has also been used as a transportation fuel for more than half a century. Taxicab companies, government agencies, and school districts which operate fleets of vehicles are the main consumers of propane as a transportation fuel. Since 1938, when official records on this use of propane were first compiled, more than 30 billion gallons have been used in engines in the United States. And during the past 12 years, almost 2.3 million propane gas carburetors have been sold. Currently, about six percent of propane's use is for transportation.

There are some interesting characteristics about propane which make it an ideal engine fuel. First, propane is clean-burning; it leaves no lead, varnish, or carbon deposits that cause the premature wearing of pistons, rings, valves, and spark plugs. The engine stays clean, free of carbon and sludge. This means less maintenance, drastically reduced downtime, and an extended engine life.

Also, propane is all fuel. It doesn't require additives usually blended into some grades of gasoline. Even without additive boosters, propane's octane rating of 110 is equal to and, in most cases, higher than available gasoline.

Propane-fueled engines also reduce air pollution. Research conducted by the U.S. Bureau of Mines indicates that carbon monoxide emissions from engines using propane are 50 percent to 92 percent lower than emissions from gasoline-fueled engines while hydrocarbon emissions are 30 percent to 62 percent lower.

So why isn't propane used as a transportation fuel more often? For one reason, it's not as conveniently available as gasoline. Second, the cost of converting an engine to use propane fuel is often prohibitive. Also, there is a slight drop in miles per gallon when propane is used to fuel vehicles.

Economics of Propane

Unlike the natural gas industry which distributes gas to consumers through public utilities, the propane industry is not regulated by the government. The propane industry has over 3,500 companies with approximately 109,000 local distribution facilities, enabling the consumer to shop around for the best price and service.

So, how does the cost of heating with propane compare to other common residential heating sources? According to a 1988 U.S. Department of Energy report, heating with propane is far cheaper than electricity, but more expensive than natural gas, heating oil, or kerosene. Specifically, the report showed the cost of heating per million Btu (British thermal units) as $7.69 for propane; $23.56 for electricity; $5.62 for natural gas; $5.98 for heating oil; and $5.78 for kerosene.

Energy Fact Sheet: Solar Energy

1989 Facts At A Glance

Classification: *Renewable*

Reserves: *Unlimited*

Major Uses: *Heating and Producing Electricity*

What Is Solar Energy?

Solar energy is a renewable energy source that comes from the sun. Every day the sun radiates, or sends out, an enormous amount of energy. In fact, it radiates more energy in one second than people have used since the beginning of time.

Where does all this energy come from? It comes from within the sun itself. Like all stars, the sun is a big gas ball made up mostly of hydrogen and helium. The sun generates energy in its core in a process called **nuclear fusion**. During nuclear fusion, the sun's extremely high pressure and hot temperature (more than 20 million degrees Fahrenheit!) cause hydrogen atoms to come apart and their nuclei (the central cores of the atoms) to *fuse* or combine. Thus, four hydrogen nuclei fuse to become one helium atom. But the helium weighs less than the four nuclei that combined to form it. The matter that is lost during nuclear fusion is emitted into space as radiant energy.

It takes millions of years for the energy in the sun's core to make its way to the solar surface, and then just a little over eight minutes to travel the 93 million miles to earth. The solar energy travels to the earth at a speed of 186,000 miles per second, the speed of light.

Only a small portion of the energy radiated by the sun into space strikes the earth, one part in two billion. This amount of energy, however, is enormous. Approximately 120 quads of energy strike the United States each day, enough to supply the nation's energy needs for one and a half years!

Where does all this energy go? About 15 percent of the sun's energy that hits the earth is reflected back into space. Another 30 percent of the solar energy is used to evaporate water, which, lifted into the atmosphere, produces rainfall. Solar energy is also absorbed by plants, the land, and the oceans. The rest could be used to supply our energy needs.

History of Solar Energy

Man has harnessed solar energy for centuries. Since ancient times man has recognized that the heat and light from the sun are a very effective source of energy. Many of the past attempts to put sunlight to work involved collecting the sun's rays and focusing them to produce high temperatures. As early as the 7th century B.C., simple magnifying glasses were used to concentrate the light of the sun into beams so hot they would cause wood to catch fire. And over 100 years ago in France, heat from a solar collector was used to make steam to drive a steam engine.

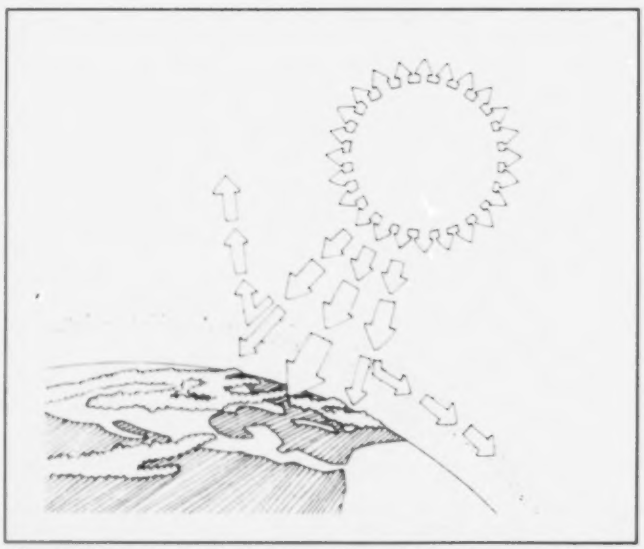
But only in the beginning of this century did research on the use of solar energy begin in earnest. Developments included the invention of a remarkably efficient solar boiler in 1936 by Charles Greeley Abbott, an American astrophysicist.

The solar water heater gained a great deal of popularity at this time in Florida, California, and the Southwest. The industry started in the early 1920's and was in full swing just prior to World War II. This growth lasted until the mid 1950's when low-cost natural gas, which was suddenly very plentiful, became the primary fuel for heating. In fact, even though there was a great deal of experimentation going on in the field of solar energy, including the construction of many solar homes, the public and world governments remained largely indifferent to the possibilities of solar energy until the energy shortages of the 1970's. Today, solar energy is used for both heating and producing electricity.

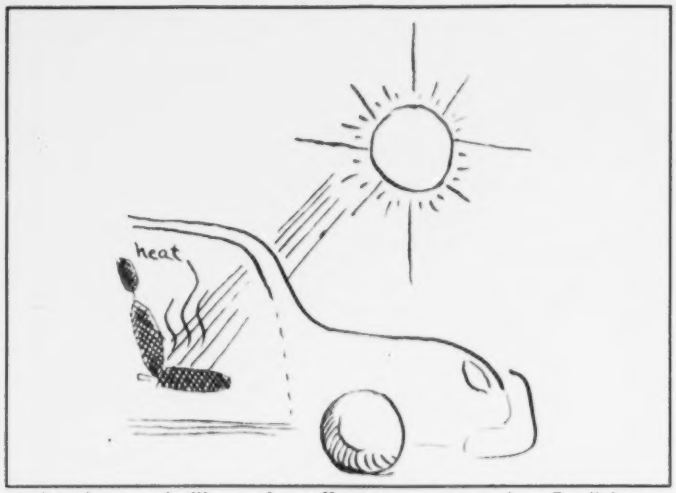
Heating with Solar Energy: *Space Heating and Hot Water Heating*

The most popular, and now fairly standard, use of solar energy is for heating homes ("space" heating) and providing hot water.

But it's not as easily accomplished as you might think. Capturing sunlight and putting it to work is particularly difficult because the solar energy that reaches the earth is spread out over a large area. The



About 120 quads of solar energy strike the United States each day—enough to supply the nations's energy needs for 1.5 years.



A closed car works like a **solar collector** *on a sunny day. Sunlight passes through the glass, is absorbed and changes into heat energy, and then gets trapped inside the closed car.*

sun simply does not deliver that much energy to any one place at any one time. In fact, the rate at which a location on earth receives solar energy depends on a number of conditions. These include the time of day, the season of the year, the latitude of the area, and the clearness or cloudiness of the sky.

A **solar collector** is one way to collect heat from the sun. A closed car on a sunny day is like a solar collector. As sunlight passes through the car's glass windows, it is absorbed by the seat covers, walls, and floor of the car. The light that is absorbed changes into heat. The car's glass windows let light in, but don't let all the heat out. (This is also why greenhouses work so well and stay warm year-round.)

Thus, a solar collector does three things: 1) it allows sunlight inside through glass (or plastic); 2) it absorbs the sunlight and changes it into heat; and 3) it traps most of the heat inside.

Solar Space Heating

Solar space heating systems can be classified into two general types: passive or active. A "hybrid" system is a mixture of the two.

In a **passive** solar home, the whole house operates as a solar collector. A house is designated "passive" because it does not use any special mechanical equipment such as pipes, ducts, fans, or pumps to transfer the heat that the house collects. Instead, passive solar homes rely on the use of natural methods (i.e., conduction, convection, and radiation) for heating.

Like the car, a passive solar home absorbs solar energy through its walls and floors, converting the energy into heat. A passive solar home relies on properly oriented windows. Since the sun shines from the south in North America, passive solar homes are built so that most of the windows face south. They have very few or no windows on the north side.

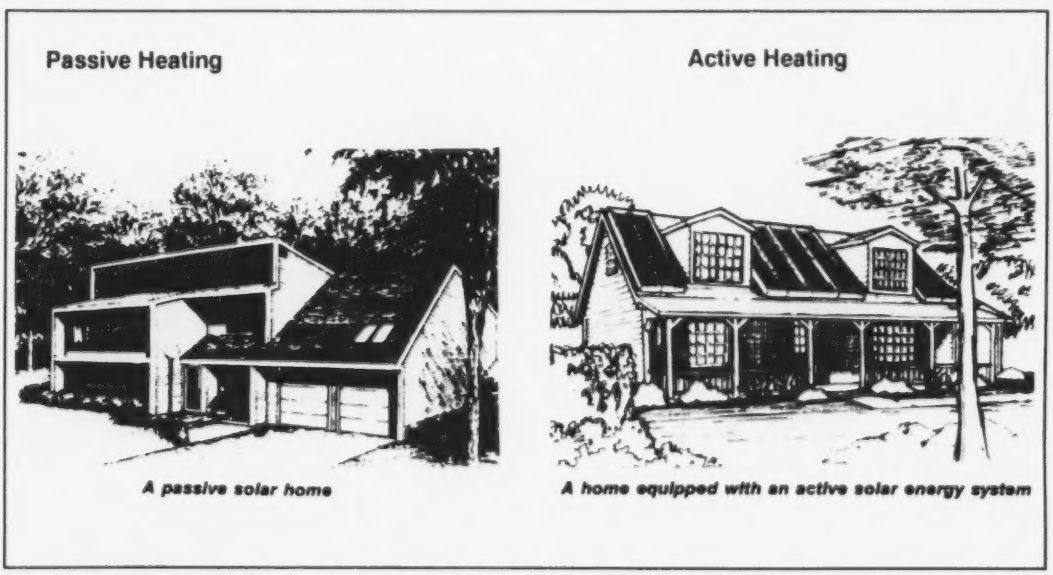
To control the amount of heat in a passive solar house, the doors and windows must be closed or opened to keep heated air in or let heated air out. At night, special heavy curtains or shades are pulled over the windows to keep the daytime heat inside the house. In the summertime, awnings or roof overhangs help to cool the house by shading the windows from the high summer sun.

Heating a house by warming the walls or floors is generally more comfortable than heating the air inside a house. And passive buildings are quiet, peaceful places to live. A passive solar home can obtain 50 to 80 percent of its annual space heating requirements from the sun. Over 200,000 homes in the U.S. have passive solar features.

But because not all the heating requirements can be met by using passive solar energy, many homeowners install equipment (such as fans to help circulate air to desired locations) to get more out of their passive solar homes. When special equipment is added to a passive solar home, the result is called a **hybrid** system.

In contrast to a passive solar system, an **active** solar system uses non-solar energy to help heat a house or building. Mechanical equipment, such as pumps and blowers, are typically used.

Active systems also use special solar collectors which look like boxes covered



Passive vs. Active Solar Homes: *A passive solar home relies on properly oriented windows for heating; an active solar home uses mechanical equipment (pumps, blowers) to help heat the house.*

with glass. Dark-colored metal plates inside the boxes absorb the sunlight and change it into heat. (Black absorbs sunlight more effectively than any other color.) Air or a liquid flows through the collectors and is warmed by this heat. The warmed-up air or liquid is then distributed to the rest of the house just like it would be with an ordinary furnace system.

Solar collectors are usually placed high on roofs where they can collect the greatest amount of sunlight. They are also put on the south side of the roof in a place where no tall trees or tall buildings will shade them. Today, over 100,000 homes and businesses use active solar heating systems.

Storing Solar Heat

The challenge confronting any solar heating system – whether passive, active, or hybrid – is heat storage. Solar heating systems must include some way of storing the heat that is collected during sunny weather so that there is still enough heat to keep people warm at night or during cloudy weather.

In a passive system, heat is stored by using dense interior materials that have a high heat-holding capacity – masonry, adobe, concrete, stone, or water, for example. These materials absorb surplus heat from the sunlight entering the windows and radiate it back into the room after dark. Some passive homes have walls up to one foot thick.

In active systems, either a hot liquid is moved to large storage tanks, or hot air is moved to bins of rocks beneath the building. When heat is needed, the hot liquid or air is taken out of storage and distributed to living areas.

Houses with active or passive solar heating systems also have furnaces, wood-burning stoves, or some other heat source to provide heat in case there is a long period of cold or cloudy weather. This is called a backup system.

Solar Hot Water Heating

Even more so than space heating, the most widely used and simplest way of using solar energy is for producing hot water. The heating of water is usually the second leading home energy expense, costing the average family over $400 a year. Depending on where you live, and how much hot water your family uses, a solar water heater can pay for itself in as little as five years. A well-built and well-maintained system can last 15-20 years.

A solar water heater works in basically the same way as solar space heating. A solar collector is mounted on the roof, or in an area of direct sunlight. It collects sunlight and converts it to heat. When the collector becomes hot enough to heat water (for home applications, usually no more than 140 degrees F), a thermostat causes a pump to start operating. Water begins to circulate from a storage tank through the collector pipes and then goes back again to the tank. Eventually, the tank, which is well-insulated to prevent heat loss, becomes a small reservoir of heated water. This hot water may then be piped to a faucet or even to a radiator for heating a house.

In Australia, Japan, and Israel, solar water heaters are widely used. Although the use of solar water heaters was widespread in America before World War II, use eventually tapered off. Now however, the 1980's has seen a resurgence of solar water heaters. Today, over 1.5 million homes in the U.S. use solar heaters to heat water for their homes or swimming pools.

Solar Electricity: *Photovoltaics and Thermal Power*

In addition to heating living spaces and water, solar energy can also be used to produce electricity. Electricity can be generated using photovoltaics or solar thermal systems.

Photovoltaic Electricity

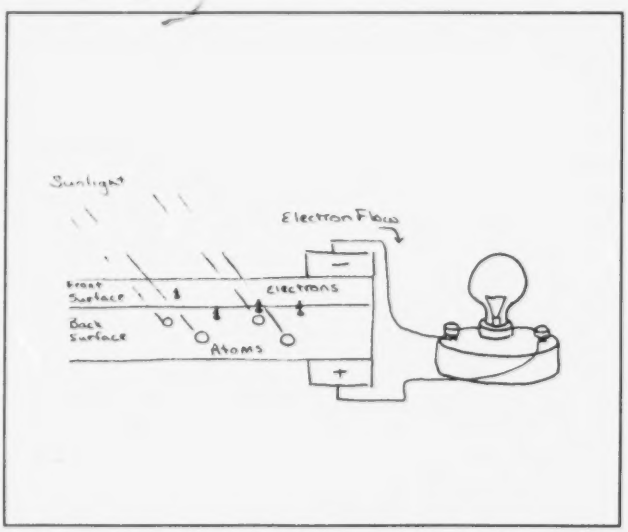
Photovoltaic comes from the words *photo* meaning "light" and *volt*, a measurement of electricity. Solar-powered calculators, toys, telephone call boxes, and other electrical devices run on photovoltaic (PV) cells which convert light directly into electricity.

The element used to make photovoltaic cells is silicon (sand), the second most common substance on earth. Once the silicon has been made into slices, the slices are changed ever so slightly by adding small amounts of other chemicals. As these chemicals are added, the atomic make-up of the silicon atom is changed.

Depending on which chemicals are added, the silicon slices either end up having too many electrons or too few electrons for the number of atoms present. A silicon slice that has extra electrons is known as N-type silicon, while a slice that has too few electrons is known as P-type silicon. Bringing together a slice of each type of silicon to form a "sandwich," and attaching a wire to the outer surface of each silicon layer, produces electricity.

The electricity is produced when light strikes certain chemical substances (in this case, the two silicon layers), causing a push on the electrons in the substances. Once the electrons start flowing, an electric current results.

Photovoltaic technology has greatly improved since 1954 when Bell Labs demonstrated the first practical solar cell. Solar batteries (two or more PV cells connected together to give increased electric current) were used extensively in the early days of the space program. When placed in a series, solar cells can supply energy to anything currently powered by battery or electrical power. In 1986, U.S. manufacturers sold



A photovoltaic cell is made of silicon, the same substance that makes up sand. When sunlight strikes a solar cell, it is changed directly into electricity.

Solar Electricity R & D

Photovoltaics

Currently, most PV systems have efficiency ratings of about 10 percent. This means that about 10 percent of the energy captured by the PV cells is converted into electricity. But new PV systems recently developed in the laboratory are more than three times efficient as current systems, with a 35 percent efficiency rating – probably the maximum limit for solar cells.

Solar Thermal Power

Another new idea on the solar horizon is the **solar pond**. *A solar pond works by trapping heat at the bottom of a pond and then using that heat to generate electricity. Salt is used to keep the heat entering the pond from escaping. The bottom of the pond contains a heavy salt concentration. Upward from the bottom, most of the rest of the pond, known as the gradient zone, has progressively less salt in the water until near the surface the salt content is small. Typically, up to 1/3 of the sun's energy that falls on the pond's surface reaches the bottom region. The gradient zone, due to a lack of circulation, minimizes heat loss upward.*

One great advantage of solar ponds is that they are not as weather dependent as other solar thermal systems. Heat stored in the lower layer of a solar pond can be extracted days or weeks after it has been collected. The pond can deliver heat continuously, day or night. The sun need not be shining when energy is needed.

ten megawatts worth of PV systems. By the year 2010, PV systems are projected to produce over 1/2 of one percent of the electricity produced in this country.

Solar cells consume none of our precious energy resources, make no contribution to noise pollution, have the reliability inherent in a system with no moving parts, do not represent a health hazard, and contribute no harmful waste products to the environment.

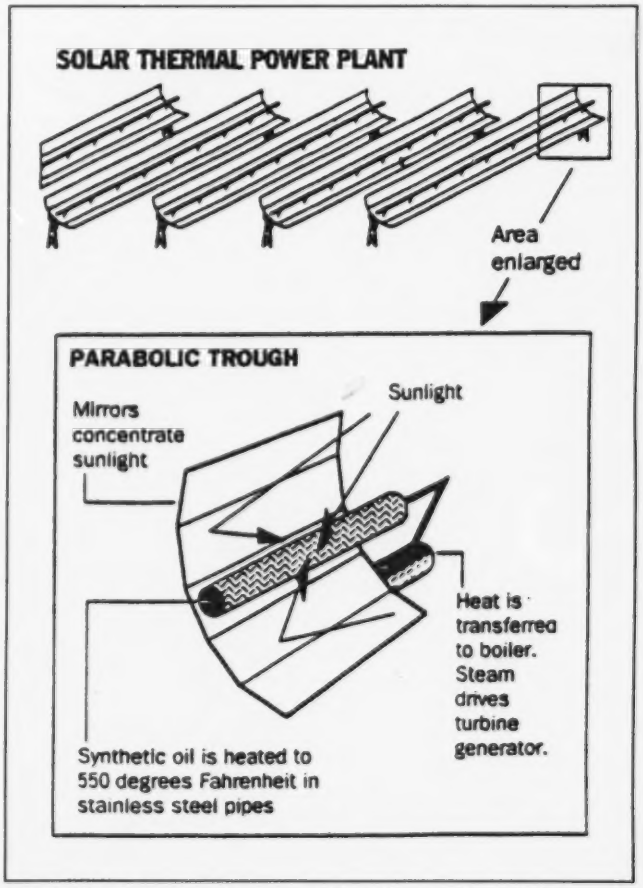
The problem is cost. Photovoltaic technology is still expensive compared to other ways of producing electricity. Most PV systems produce electricity at 25-35 cents per kwh, about four to six times the cost of coal-fired power plants. So far, photovoltaic systems are cost-effective only in remote areas that are at least 1/2 mile away from a utility company's power lines.

Solar Thermal Power Electricity

Like photovoltaic cells, solar thermal systems change sunlight into electricity. But they do it in a different way. Generally, solar thermal systems use solar collectors with mirrored surfaces to concentrate sunlight onto a receiver which heats a liquid. The super-heated liquid is used to make steam which drives a turbine to produce electricity in the same way that coal, oil, or nuclear power plants do. Solar power plants then sell their electricity to utility companies which, in turn, distribute it to customers.

Solar thermal systems may be one of three types: central, dish, or trough. A central receiver system uses large mirrors on top of a high tower to collect sunlight. This system has been dubbed a "solar power tower." Another system uses a dish-shaped solar collector to collect sunlight. This system resembles a television satellite dish. A third system uses mirrored troughs to collect sunlight. Trough systems have proven to be the most successful. In fact, the LUZ solar power plant in California is the first and only solar plant to generate electricity economically. Dollar for dollar, it has always been cheaper to use conventional sources of energy (coal, oil, nuclear) to generate electricity. But the LUZ plant has turned that around, producing electricity at 8 cents per kwh. In comparison, coal and oil-fired plants produce electricity from 6 to 9 cents per kwh while nuclear plants produce electricity at 10 cents per kwh. And these costs do not reflect the environmental and health costs associated with conventional power plants. With the addition of six more plants in 1994, the LUZ plant will produce electricity even more cheaply – at just 5 cents per kwh.

NOTE: For more information about the LUZ solar power plant, please see the Fall 1989 edition of NEED's magazine,


SOLAR THERMAL POWER PLANT
Area enlarged
PARABOLIC TROUGH
Sunlight
Mirrors concentrate sunlight
Heat is transferred to boiler. Steam drives turbine generator.
Synthetic oil is heated to 550 degrees Fahrenheit in stainless steel pipes

The LUZ solar power plant uses solar collectors shaped like troughs to concentrate sunlight. LUZ's solar power plant currently produces 200 megawatts of electricity a year.

Printed on recycled paper

Energy Fact Sheet: Uranium/Nuclear Energy

1989 Facts At a Glance

Classification: *(Uranium) Nonrenewable*

Reserves: *(Uranium) 500 years*

Percent of U.S. energy production: *8.6%*

Percent of U.S. energy consumption: *7.1%*

Major Use: *Electricity (19% of U.S. electricity)*

What Is Nuclear Energy?

Nuclear energy is energy that comes from the nucleus (core) of an atom. Atoms are the particles that make up all objects in the universe and consist of neutrons, protons, and electrons. Nuclear energy is released from an atom through two processes: nuclear fusion and nuclear fission. In **nuclear fusion**, energy is released when the nuclei of atoms are combined or *fused* together. This is how the sun produces energy. In **nuclear fission**, energy is released when the nuclei of atoms are split apart. Nuclear fission is the only method currently used by nuclear power plants to generate electricity.

The fuel most widely used by nuclear power plants for fissioning is **uranium**. Uranium is the heaviest of the 92 naturally occurring elements and is classified as a metal. It is also one of the few elements that is easily fissioned. Uranium was formed when the earth was created and is found in rocks all over the world. Rocks that contain a lot of uranium are called uranium ore, or pitchblende. Uranium, while abundant, is a nonrenewable source of energy.

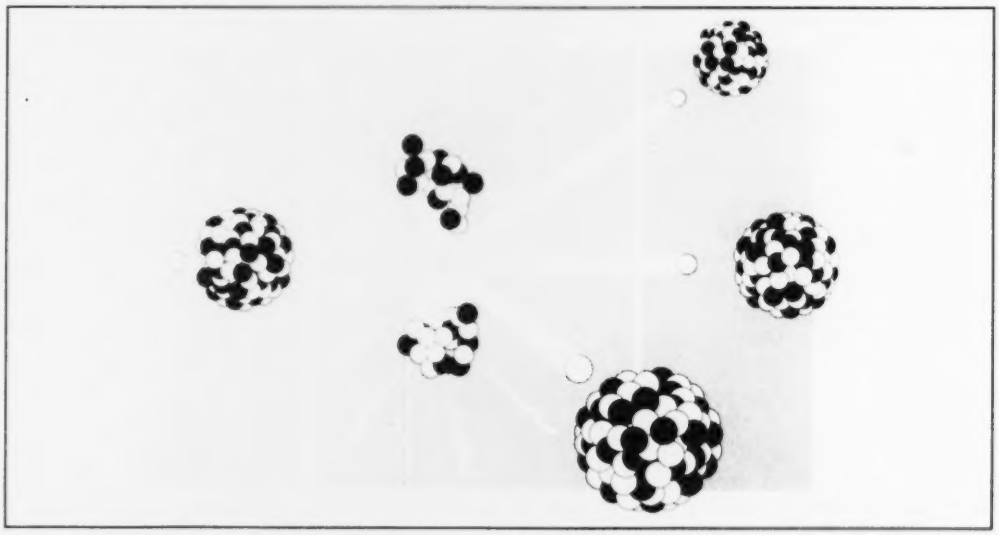
Two forms (isotopes) of uranium are found in nature, uranium-235 and uranium-238. These numbers refer to the number of neutrons and protons in each atom.

Uranium-235 is the form commonly used for energy production because, unlike uranium-238, its nucleus splits easily when bombarded by a neutron. During fissioning, the uranium-235 atom absorbs a bombarding neutron, causing its nucleus to split apart into two atoms of lighter weight. At the same time, the fission reaction releases energy in the form of heat, radiation, and more neutrons. The newly released neutrons go on to bombard other uranium atoms, and the process repeats itself over and over. This is called a **chain reaction**.

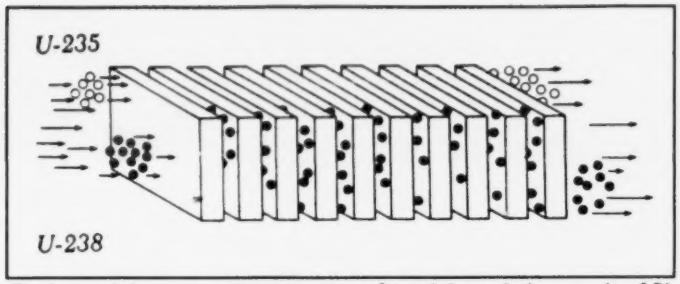
History of Nuclear Energy

Compared to other energy sources, nuclear energy is a very new way to produce energy. It wasn't until the early 1930's that scientists discovered that the nucleus of an atom is made up of protons and neutrons. But just a few years later, in 1938, two German scientists split the nucleus of the atom apart by bombarding it with a neutron – the process called "fission." Soon after, a Hungarian scientist discovered the "chain reaction" and its ability to produce enormous amounts of energy. Under the dark cloud of World War II, nuclear fission was first used to make a bomb. After the war, nuclear fission was developed for generating electricity.

The first commercial nuclear power plant came on line in Shippingport, Pennsylvania in 1957. Since then, the industry has experienced dramatic shifts in fortune. In the early years, through the mid 1960's, government and industry experimented with demonstration and small commercial plants. This was followed by a period of rapid expansion in nuclear capacity between 1965 and 1975. Public opposition to nuclear power plants and the Three Mile Island accident in 1979 have slowed this growth rate considerably from the mid 1970's to the present. In fact, in this decade, no expansion in nuclear capacity is expected.



The Chain Reaction: **1.** *A neutron is about to hit the nucleus of a uranium atom.* **2.** *The uranium nucleus splits (fissions) apart, releasing heat and several more neutrons.* **3.** *The chain reaction begins: the newly released neutrons hit other nuclei, causing them to fission and so on.* *Illustration Courtesy of USCEA.*



During enrichment, uraium atoms are forced through thousands of filters. Uranium-235 moves through the filters more easily, increasing the concentration of uranium-235 to about three percent.

The Nuclear Fuel Cycle

The chain of steps – from mining the uranium ore, through its use in a nuclear reactor, through disposal – is known as the **nuclear fuel cycle**.

Mining. The first step in the nuclear fuel cycle is mining the uranium ore. Workers mine uranium ore much as they mine coal, in deep underground mines or in open-pit surface mines. A ton of uranium ore in the U.S. typically contains three to four pounds of uranium. Domestic uranium comes mostly from New Mexico and Wyoming. Uranium is also imported from other countries. Last year, the United States imported 44 percent of its uranium.

Milling. After it has been mined, uranium ore is crushed. The crushed ore is usually poured into an acid, which dissolves the uranium, but not the rest of the crushed rock. The acid solution is drained off and dried, leaving a yellow powder called "yellowcake," consisting mostly of uranium. This process of removing uranium from the ore is called uranium milling.

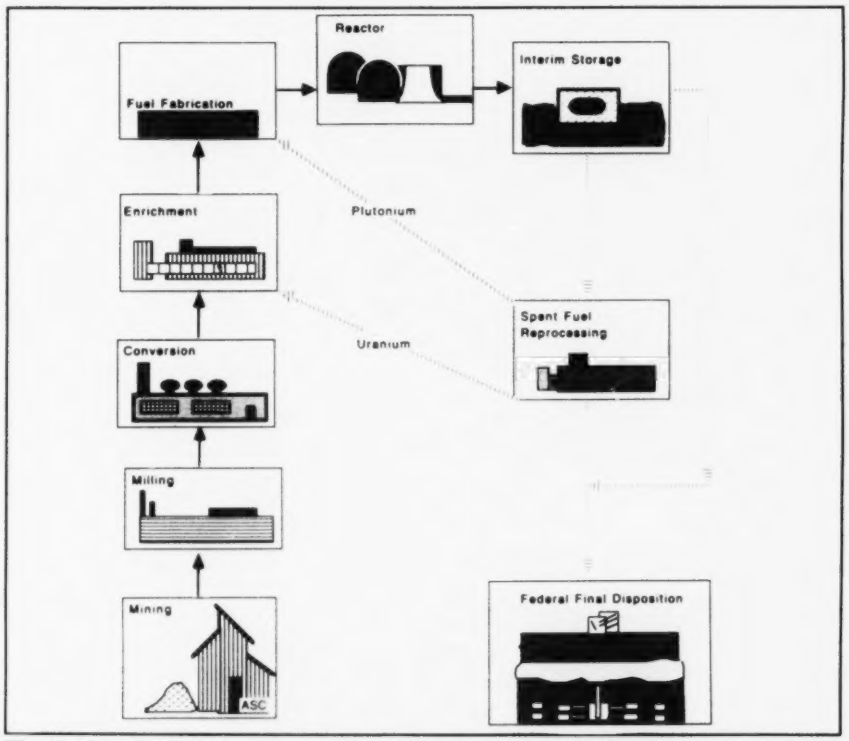
Conversion. The next step in the cycle is the conversion of the yellowcake into a gas called uranium hexâfluoride, or UF6. The uranium hexafluoride is then shipped to a gaseous diffusion plant for enrichment.

Enrichment. Because less than one percent of uranium ore contains uranium-235, the form used for energy production, uranium must be treated to increase the concentration of uranium-235 before it can made into a reactor fuel. This treatment process – called uranium enrichment – increases the percentage of uranium-235 from one to three percent. It takes place at a gaseous diffusion plant where the uranium hexaflouride is pumped through filters that contain extremely tiny holes. Because uranium-235 has three fewer neutrons and is therefore about one percent lighter than uranium-238, uranium-235 moves through the holes more easily than uranium-238. In this way, the percentage of uranium-235 increases by the time the gas passes through thousands of filters. Gaseous diffusion is not the only method of uranium enrichment, but it is the only technique used in the United States.

Fuel Fabrication. The enriched uranium is then taken to a fuel fabrication plant where it is prepared for the nuclear reactor. Here, the uranium is made into a solid ceramic material (uranium dioxide) and formed into small barrel-shaped pellets. These ceramic **fuel pellets** can withstand very high temperatures, just like the ceramic tiles on the space shuttle. Fuel pellets are about the size of your fingertip, yet each one can produce as much energy as 120 gallons of oil. The pellets are then stacked and sealed in 12-foot metal tubes called **fuel rods**. The fuel rods are then bundled into groups called **fuel assemblies**.

Nuclear Reactor. The uranium fuel is now ready for use in the nuclear **reactor**. The reactor **core** is where the fissioning takes place. Surrounding the core of the reactor is a shell called the reactor pressure vessel. To prevent heat or radiation leaks, the reactor core and the vessel are housed in an air-tight containment building made of steel and concrete several feet thick.

The reactor core houses approximately 200 fuel assemblies. Spaced between the fuel assemblies are movable **control rods**. Control rods absorb neutrons and slow down the nuclear chain reaction. Control rods, in other words, help control the fissioning process. Water also flows up through the fuel assemblies and control rods to remove some of the heat of the nuclear chain reaction.



The Nuclear Fuel Cycle. *Uranium is mined and processed before it is used as a fuel in a nuclear power plant. Illustration Courtesy of Energy Information Administration.*

What Is Radiation?

Radiation is energy in the form of rays or particles. Some atoms – the radioactive ones – have more neutrons than protons, making them unstable. In a natural process called "radioactive decay," these atoms give up their extra neutrons and become stable.

Radiation can not be touched, seen, or heard, but it is around us all the time. Natural sources of radiation include cosmic rays from outer space, minerals in the ground, and radon in the air. Man-made sources of radiation include the x-ray equipment used by doctors, smoke detectors, color television sets, and luminous dial clocks. Nuclear waste is another kind of man-made radiation which usually contains higher than natural concentrations of radioactive atoms.

The three types of radiation associated with nuclear radiation are: alpha, beta, and gamma. Alpha radiation consists of positively charged particles. These particles can be blocked by a sheet of paper or the outer layer of body skin.

Beta radiation consists of high-speed electrons. Beta radiation is more penetrating than alpha radiation and can pass through about an inch of water or body skin.

Gamma radiation consists of high-energy electromagnetic waves and can pass through the body just like medical x-rays do. Gamma rays can be blocked by several inches of lead, several feet of concrete, or a large amount of water.

High levels of radiation are dangerous. They may cause cancer or genetic defects. The unit used to measure radiation is the rem and millirem (1/1000 of one rem). All told, the average American is exposed to about 360 millirem a year from natural and man-made sources. About 260 millirem of that total comes from natural ("background") sources of radiation. Another 55 millirem comes from medical x-rays and about 10 millirem from a variety of sources including mineral mining, burning fossil fuels, and such consumer products as color television sets and luminous dial clocks. Radiation emitted from nuclear power plants accounts for only about .01 millirem of exposure per year. In comparison, a single dose of 600,000 millirem received all at one time is considered fatal to 50 percent of the people exposed to it.

Nuclear fuel generates heat in a reactor just as coal or oil generate heat in a boiler. Likewise, the heat is used to boil water into steam which turns a turbine generator to produce electricity. Afterwards, the steam is condensed back into water and cooled in a separate structure called a **cooling tower**. In this way, the water can be used again and again.

Spent Fuel Storage. Like most industries, nuclear power plants produce waste. One of the main concerns about nuclear power plants is not the amount of waste created, which is quite small compared to other industries, but the radioactivity of some of that waste. When uranium is used as a fuel in a nuclear reactor, the fission process creates radioactive waste products. After three or so years, these non-fissionable waste products build up in the fuel rods, making the chain reaction more difficult. Utility companies generally replace one-third of the fuel rods every 12 to 18 months to keep power plants in continuous operation. The fuel that is taken out of the reactor is called **spent fuel**. The spent fuel contains both radioactive waste products and some unused nuclear fuel.

The spent fuel is stored near the reactor in a deep pool of water called the **spent fuel pool**. During storage, the spent fuel cools down and begins to lose most of its radioactivity through radioactive decay. In three months, the spent fuel will lose 50 percent of its radiation; in one year, 80 percent; in 10 years, 90 percent. The spent fuel pool is intended as a temporary method for storing nuclear waste. Eventually, the spent fuel will be reprocessed or transported to a federal disposal site that has been specially designed for the permanent storage of nuclear waste.

Reprocessing. As mentioned above, spent fuel contains both radioactive waste products and unused nuclear fuel. In fact, about one-third of the nuclear fuel remains unused when the fuel rod must be replaced. **Reprocessing** is the separation of the unused nuclear fuel from the waste products so that it can be used in a reactor again and again. But currently the industry simply stores the spent fuel in spent fuel pools – *without* reprocessing. There are a couple of reasons for this. First, the federal government's policy on reprocessing spent fuel has wavered in recent years. (President Carter did not support reprocessing while his successor, President Reagan, did.) Second, new uranium fuel is very cheap for utility companies to purchase.

The Federal Repository for Nuclear Waste

In 1982, the U.S. Congress passed the Nuclear Waste Policy Act. This law set up a schedule for the site selection, construction, and operation of America's first high-level nuclear waste storage facility, called a **repository**. The law also required each utility company to deposit 1/10 of a cent for each kilowatt-hour of nuclear-generated electricity to a special fund. (This means that the average American household, which uses approximately 7,500 kilowatt-hours a year, contributes $7.50 a year to the fund if it gets all its electricity from a nuclear power plant.) The fund allows the U.S. Department of Energy to research the construction of safe storage-disposal sites for high-level radioactive waste from nuclear power plants.

The most recent legislation is the Nuclear Waste Policy Amendments Act which Congress passed in 1987. This act moved the start of waste burial from 1998 to 2003, and designated Yucca Mountain, Nevada as the nation's first repository site.

If the current plan is approved (the state of Nevada is challenging the location of the repository in court), nuclear waste will be sealed in steel canisters and stored in underground vaults that have been drilled into the stable rock formations at Yucca Mountain. It's important to locate the repository in stable and dry types of rock formations because portions of the waste will remain radioactive for as long as 1,000 years.

Another important aspect about the Yucca Mountain site is its isolation; hardly anyone lives near the future

repository. If the site is approved, nuclear waste will be treated, placed in a long tunnel, and taken to subterranean vaults beneath the mountain for storage.

Safety Lessons – the Hard Way

The greatest potential risk from nuclear power plants is the release of high-level radiation. In the United States, plants are carefully designed to contain radiation, and emergency plans are in place to alert and advise residents if there is an accident.

Two serious accidents have occurred since the industry began over 30 years ago – Three Mile Island in the United States (1979) and Chernobyl in the Soviet Union (1986). At Three Mile Island, about half the uranium fuel melted when water to the reactor core was inadvertantly cut off. A small amount of radioactive material escaped into the surrounding area before the mistake was discovered. But due to the safety design features of the plant – multiple barriers contained most of the radiation – no one was injured or died as a result of this accident. The accident at Chernobyl was far more serious. It happened when two explosions blew the top off the reactor building. A lack of containment structures and other design flaws caused the release of a large amount of radioactive material into the surrounding area. More than 100,000 people were evacuated from their homes and about 200 workers were treated for radiation sickness and burns; 32 of them died.

Production and Consumption of Nuclear Energy

Nuclear energy is an important source of electricity in the United States – it's second only to coal. In 1989, 527 billion net kilowatt-hours came from nuclear power. That's about 19 percent of the electricity consumed in this country.

Over 90 percent of the people in the United States get at least some of their electricity from nuclear power plants. Even if your state does not have a nuclear power plant, your local utility company may sometimes buy electricity from utilities in neighboring states that do have nuclear power plants. This may happen during a summer heat wave or when a utility shuts down a power plant for service.

At the end of 1989, there were 109 nuclear power plants in the United States. Nuclear capacity is projected to increase from 95.1 gigawatts of electricity at the end of 1988 to about 105 gigawatts of electricity in 1990. For the period from 1990 through 2000, limited, if any, expansion in nuclear capacity is projected.

In other parts of the world, nuclear energy is a growing source of electrical power. Nuclear energy now provides about 17 percent of the world's electricity. This is equivalent to the entire coal production of either the United States or the Soviet Union. France, Belgium, and the Republic of Korea are the world leaders in producing electricity from nuclear power.

Licensing Nuclear Power Plants

All U.S. nuclear power plants must obtain a permit to start construction and, later, a license to begin operation. Obtaining a license is a lengthy and complex procedure which substantially increases the cost of building a nuclear plant.

Many studies are conducted to find the best site for a nuclear power plant. In addition, researchers investigate how a plant will affect the local economy and environment. Detailed plans and reports are submitted to the **Nuclear Regulatory Commission**, the federal government agency responsible for licensing nuclear power plants and overseeing their construction and operation. When the builders of a nuclear power plant apply for a license, local hearings are held so people can testify and air their concerns and opinions. After a plant is built, the Nuclear Regulatory Commission sends inspectors to do on-site checks to assure a plant is operating according to its license.

Economics of Nuclear Energy

The cost of producing electricity from nuclear energy is somewhat higher than the cost of producing electricity from coal. Much of the cost of producing electricity at a nuclear plant comes not from the fuel source – uranium is relatively inexpensive at just $30 a pound – but from the cost of building the plant. Building a nuclear power plant is very expensive because of the high costs of construction, financing, and inspection.

In 1989, the cost of producing nuclear electricity was about 10 cents per kilowatt-hour. In comparison, the cost of producing electrical power from coal was six to seven cents per kilowatt-hour, while oil and gas were costlier, averaging nine cents per kilowatt-hour.

Uranium is an abundant natural resource that is found all over the world. At current rates of use, uranium resources could last more than 500 years. (A process called "breeding," which converts uranium into plutonium – an even better fuel – could extend uranium reserves for *millions* of years. Breeder reactors are already being used in France, the world leader in nuclear power production.) And because uranium is an extremely concentrated fuel source, it requires far less mining and transportation than other fuel sources for the energy it furnishes. Obtaining the same electricity from coal would require the mining, shipping, and burning of 20 million tons of coal.

Nuclear Energy and the Environment

Producing electricity from nuclear power produces no air pollution because fuel is not burned as it is in coal and oil-fired plants. In fact, using nuclear energy may become one way to solve pollution problems linked to acid rain and the "greenhouse effect."

Most experts predict that we will have to use uranium to produce the amount of electricity people will need at a cost they can afford. Whether or not we should use nuclear energy to produce electricity is a complex and controversial issue.

The NEED Project wishes to thank the U.S. Council for Energy Awareness for its help in producing this fact sheet.

Printed on recycled paper

Energy Fact Sheet: Wind

1989 Facts At A Glance

Classification: *Renewable*

Percent of U.S. energy production: *0.03%*

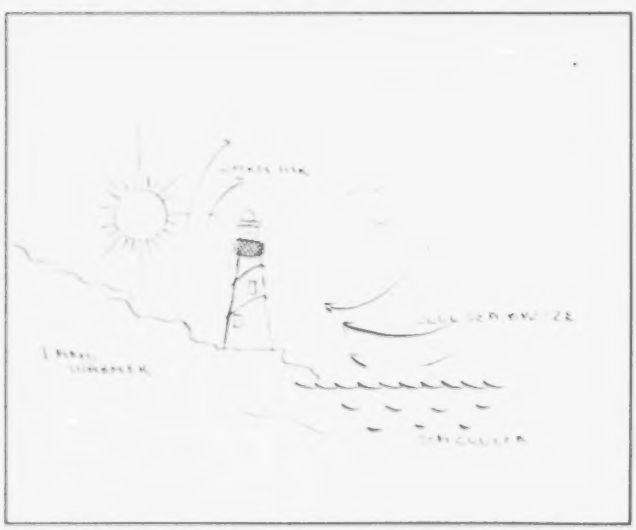
Percent of U.S. energy consumption: *0.1%*

Major Use: *Electricity*

What Is Wind?

Wind is simply air in motion. It is caused by the uneven heating of the earth's surface by the sun. This is why wind is classified by the U.S. Department of Energy (DOE) as a form of solar energy.

Since the earth's surface is made up of land, desert, water, and forest areas, the surface absorbs the sun's radiation differently. During the day, for example, air above land heats more quickly than air above water. The hot air over the land expands and rises, and the heavier, cooler air rushes in to take its place, creating local winds. At night, the winds are reversed because at this time, air cools more rapidly over land than over water. Anyone who has been on the beach knows this. In the daytime, the breezes blow off the ocean, while at night the wind is at your back. And who hasn't felt the chill of a draft in the house when the door is open? This, too, is caused by the wind. The cooler outside air rushes indoors as the hot air rises.



Ocean breezes are created by the uneven heating of land and sea.

Similarly, the large atmospheric winds that circle the earth are created because land near the equator is heated more by the sun than land near the North and South Poles.

Like solar energy, the wind is called a *renewable* source of energy because it is something we'll never run out of.

The History of Wind Machines

Throughout history man has harnessed the wind. In ancient times men used wind power to propel their sailing vessels. They also employed the wind to grind their grain by building windmills. The earliest known windmills were in western Asia. They looked like large paddle wheels. By 200 B.C., windmills were in wide use in Persia.

Later on, propeller-type windmills, like the ones we associate with Holland, came into being. In medieval times, sturdier blades and a stationary tower, whose top section could be turned to face the wind, were developed. Then about 400 years ago, people discovered that a blade works better if it's shaped with a twist. (A twist compensates for the fact that the blade moves with differing speeds at different points along its radius – slowest near the center and fastest at the tip.) Experience and invention continued to improve the construction of the windmill, and by the late 1800's the blade had become truly aerodynamic.

Prior to 1935, more than six million windmills could be seen throughout America. Most windmills were used to pump water, turn sawmills, grind grain, or produce electricity. But when power lines began to transport electricity to rural areas in 1936, the electric windmills were scarcely used for several decades. Then in the early 1970's, the oil shortages created an environment eager for alternative energy sources, paving the way for the re-entry of the electric windmill into the American landscape.

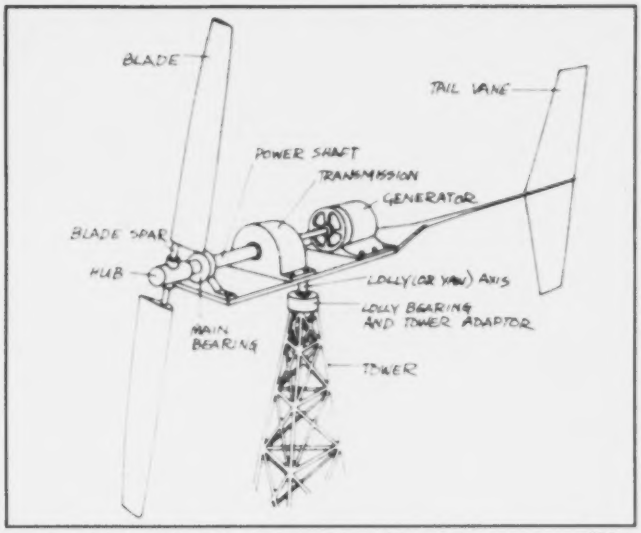
Today's Wind Machine

Yesterday's windmill is today's **wind turbine** or **wind machine**. Along with the change in name have come changes in the use and technology of the windmill.

For example, while yesterday's machines were used primarily to convert the wind's kinetic energy (energy pertaining to motion) into mechanical power to grind grain or pump water, today's wind machines are used primarily to generate electricity.

Today, a wind machine is the leading player in a wind energy conversion system. A typical **wind energy conversion system** consists of 1) a tower, 2) a control panel (usually a microprocessor which transmits information to a computer), 3) some type of electricity storage for storing the extra energy gathered when the wind is blowing hard, and, 4) the wind machine itself.

To generate electricity, today's wind machine still uses blades to collect the



An electricity-producing wind machine. Illustration courtesy of U.S. Dept. of Energy.

wind's kinetic energy. But from there, the blades, held together by a hub, are connected to a drive shaft that turns an electric generator. A magnet attached to the generator's rotating shaft moves across a wire, producing an electric current. The current then goes to a local electric utility company. A modern wind machine produces five to ten times the power of an automobile.

Horizontal vs. Vertical Wind Machines

There are basically two types of wind machines used today:

- **horizontal**, which has blades like airplane propellers; and
- **vertical**, which looks like a giant egg-beater.

The horizontal-axis wind machines are the type most commonly used to produce electricity, comprising 95 percent of all machines. A typical horizontal wind machine stands as tall as a 10-story building and has two or three blades which span 60 feet across.

Vertical-axis wind machines, on the other hand, comprise just five percent of the wind machines used today. They stand about 100 feet tall and are about 50 feet wide. The most popular vertical-axis wind machine today is the Darrieus wind turbine, named after its inventor, J.G.S. Darrieus, a French engineer. It was invented in the 1920's, and made a comeback in the 1970's. It too looks like a giant egg-beater.

Each type of wind machine has its advantages and disadvantages. For instance, horizontal-axis wind machines generally require some sort of mechanism to keep the blades facing into the wind. Vertical-axis machines don't; they can accept wind from any direction. Another advantage of vertical-axis machines is that large towers are not needed, allowing easier access for repairs. Also, because vertical-axis blades stall in high winds, they don't require the same protective features that horizontal-axis machines do. But the bottom line is that vertical-axis machines produce *less* energy than their horizontal counterparts. That's why horizontal machines are the most popular.

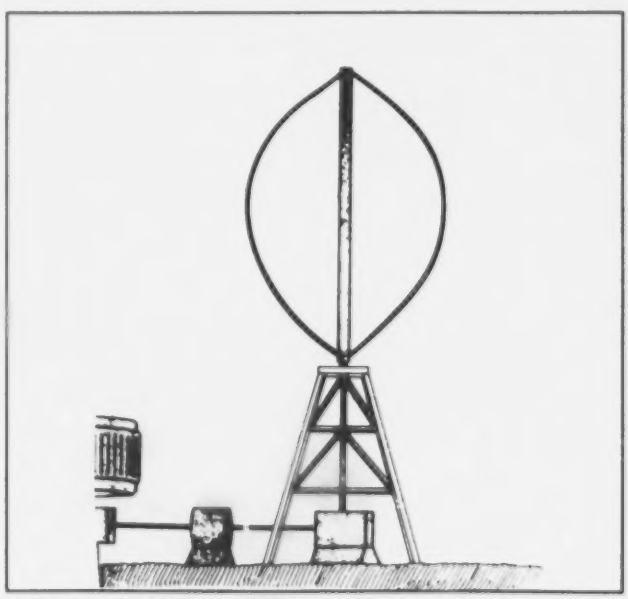
Wind Power Plants

Most of the electricity generated by the wind today is produced on huge **wind farms** or **wind power plants** that contain hundreds of wind machines. Operating similarly to most other electricity-generating power plants, wind plants sell the electricity they produce to electric utility companies.

But operating a wind power plant is not so simple. For one thing, wind plant operators must carefully plan where to locate their machines. They must consider several factors including wind availability, weather conditions, site accessibility, nearness to electrical transmission lines, site safety, and local zoning codes. They also face further restrictions. For instance, they are required to control erosion and to revegetate soils disturbed during construction of the wind plants. But mostly, they need a great deal of land. One turbine needs about two acres of land to call its own. A wind power plant takes up hundreds of acres. On the plus side, however, farming and grazing can continue around the machines virtually undisturbed once the wind machines have been installed.

Even after a plant has been built, there are still maintenance costs. In some states, all this is offet by some tax breaks (federal tax credits ran out in 1985). The Public Utility Regulatory Policies Act, or PURPA, also requires public utilities to purchase electrical energy from renewable energy producers at rates that are fair and nondiscriminatory.

Only one percent of the wind machines in the United States today are owned by homeowners who simply want to generate electricity for their own needs. A homeowner interested in setting up a wind system must also consider such factors as wind availability, weather conditions, site accessibility, nearness to transmission lines, site safety, and zoning



A Darrieus "egg-beater" rotor machine. Illustration courtesy of U.S. Dept. of Energy.

codes. Wind machines are not suited for small suburban lots; a homeowner must have at least one acre of land.

Wind Resources

Where is the best place to build a wind plant? There are many good sites for wind plants in the United States: California, Alaska, Hawaii, the Great Plains, mountainous regions. Scientists say there's enough wind in 37 of the 50 states to produce electricity from the wind. In fact, the average wind speed in the United States is about 10 mph. (An average wind speed of 14 mph is generally needed to convert wind energy into electricity economically.)

As a rule, wind speed increases with altitude and over open areas such as large bodies of water. Good sites for wind plants would include the top of a smooth, well-rounded hill, an open plain or open shoreline, or a mountain gap that produces wind funneling. The three biggest wind plants in California are located at mountain gaps.

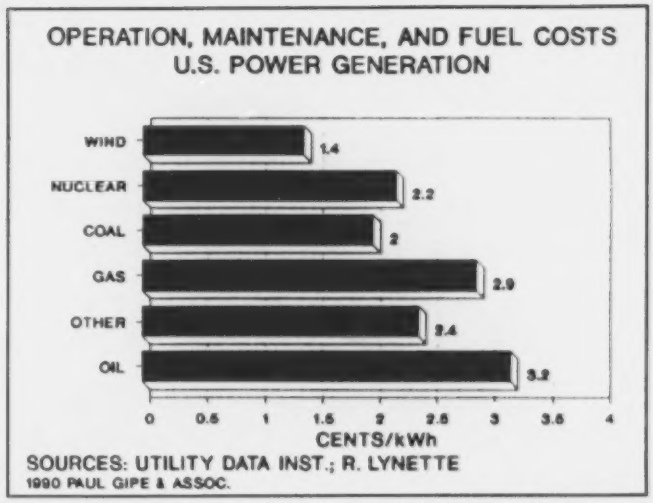
The most accurate method to determine the available wind at a given site is to take wind speed measurements using some sort of **anemometer**, or wind-measuring device. To get an accurate wind measure, data should be collected for at least four months, or even better, one year. The National Climatic Center in North Carolina also supplies wind data.

Wind is usually seasonal in nature. In Tehachapi, California, for example, more wind (80 percent) is produced from April through October than in the winter months. This is true because of the extreme heating of Mojave Desert during the summer months. The hot desert air rises, and the cooler, denser air from the San Joaquin Valley rushes through the Tehachapi mountain pass to take its place. In a state like Montana, on the other hand, more wind is produced during the winter months.

Yet these seasonal variations in wind availability are often perfectly matched to meet the electrical needs of a region. In California, the peak demand for electricity comes during the summer months when people use air conditioners for cooling. Conversely, the peak demand for electricity in Montana comes during the winter heating months.

Wind Production

Today's wind machine can produce 250-500 thousand kilowatt-hours (kwh) of electricity a year. Since an average home consumes 7,500 kwh yearly, this means that one wind machine provides enough electricity for about 50 homes per year. There are many factors to consider when trying to estimate the amount of electricity an individual wind turbine can produce. These include wind speed, wind variability (changes in wind speed), wind availability, and the reliability of the machine itself.



The cost of producing electricity from wind compares favorably to other energy sources. Graphic courtesy of AWEA.

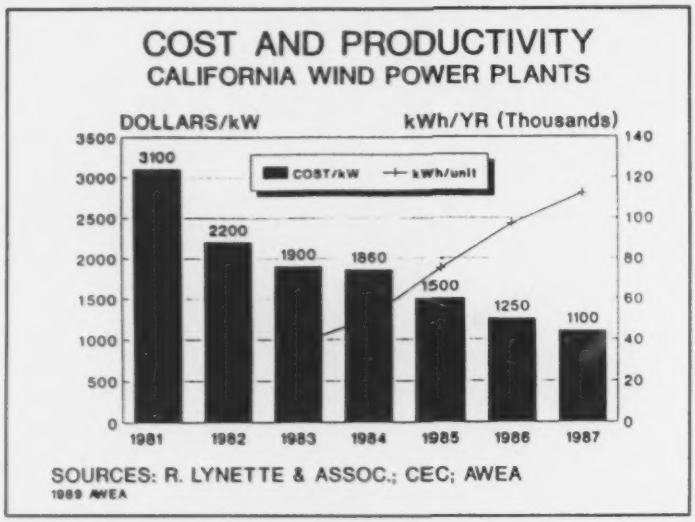
In the U.S., wind machines provided 2.2 billion kwh of energy in 1989. This equals less than 1/10 percent (1 in 1,000) of the nation's electricity used in 1989, a very small percentage. Still, this was enough energy to meet the electrical needs of 300,000 households in a city the size of San Francisco or Washington, D.C.

Using a best-case scenario, the American Wind Energy Association (AWEA) estimates that wind energy could provide 10 percent of U.S. electricity production in the next 30 years. Thus, wind energy may be an important alternative energy source in the future, but we will still need to look to other energy sources to meet our growing demand for electricity.

California is the nation's – and the world's – largest producer of wind energy. In California, some 16,000 wind turbines produce more than one percent of

Most of the nation's wind-electric generating capacity is located in California's five major wind resource areas. Illustration courtesy of AWEA.

the state's electricity. (This is equivalent to the electricity produced at a 1,400 megawatt plant, or more than a very large nuclear power plant.) In the next 15 years, wind machines could produce five percent of California's electricity. Why is California out-producing every other state? More than any other reason, wind energy has taken off in this state because of California's progressive state policies which support renewable energy sources.



The cost of producing electricity from wind has decreased in the last decade. Graphic courtesy of AWEA.

In the United States, California produces over 98 percent of the electricity generated from the wind. In fact, California produces 80 percent of the world's wind power. Other countries which have invested heavily in wind power research are Denmark, Japan, Germany, Sweden, The Netherlands, United Kingdom, and Italy.

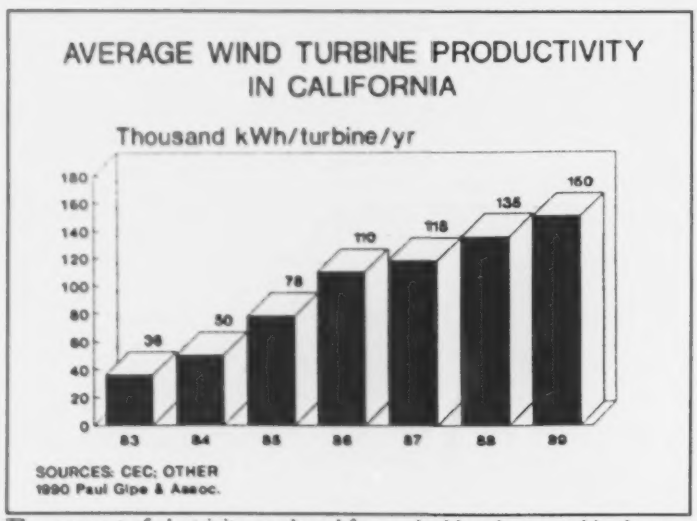
The Economics of Wind

On the economic front, there is a lot of good news for wind energy. First, a wind plant is far less expensive to construct than a conventional energy plant. Wind machines can be mass produced and quickly set up as electricity demand increases.

Wind plants are also as *efficient* as conventional sources of energy, converting 30-40 percent of the kinetic energy of the wind into electricity. In comparison, a coal-fired power plant converts about 30 percent of the heat energy in coal into electricity.

But the *capacity* rating of a wind plant is generally less than a conventional power plant because wind machines only run when the wind is blowing. Since the wind doesn't always blow, wind machines have a capacity rating of only 25 percent. In comparison, conventional power (nuclear, coal) plants typically run at about 75 percent capacity since they can run day or night, during any season of the year.

On the plus side though, the cost of producing electricity from the wind has dropped dramatically in the last two decades. Whereas electricity generated by the wind cost 30 cents per kwh in 1975, it cost just seven to nine cents per kwh in 1989. In comparison, new coal plants produce electricity at about six to seven cents a kwh. So, strictly speaking, it still costs a little less to produce electricity from conventional energy sources. But what these figures don't take into account are the *environmental* costs of producing electricity from coal or oil-fired power plants.



The amount of electricity produced from wind has increased in the past decade. Graphic courtesy of AWEA.

Wind and the Environment

In the last 15 years, uncertainty about future supplies of conventional energy sources has pushed the development of alternative energy sources. In the coming decade, environmental problems may be the biggest push for the development of alternative energy sources.

Wind energy is desirable on both fronts. First, wind is a renewable source of energy. Unlike petroleum, coal, and natural gas whose supplies are limited, we won't run out of wind.

Second, wind energy is clean. No fuel is burned to produce energy, so wind machines create no air or water pollution that most conventional sources of energy do. Thus there are no "hidden" pollution costs.

Finally, fear about environmental noise created by wind machines has proven unfounded. Today's wind machines produce only a swishing sound as the blades pass through the air.

The only environmental drawback to wind energy may be a wind plant's visual impact on the surrounding landscape. To some, the glistening blades of wind machines on the rolling hills may be beautiful; to others, they're just an eyesore.

The NEED Project wishes to thank the American Wind Energy Association for its assistance in producing this fact sheet.

Energy Fact Sheet: Coal

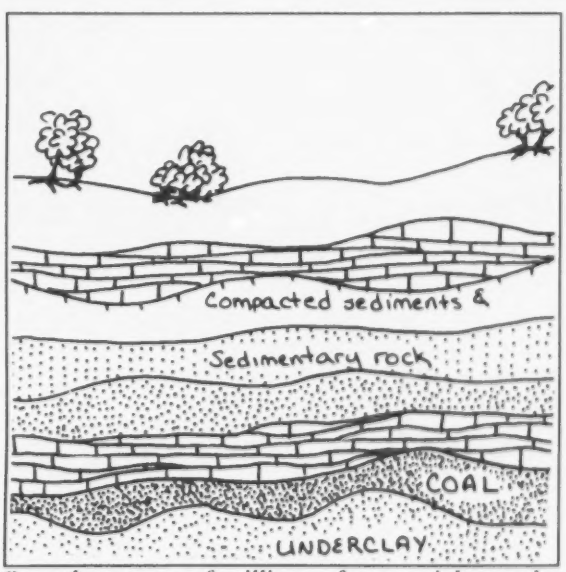
What Is Coal?

Coal is a nonrenewable fossil fuel that was formed from the remains of ancient plants. It's called a nonrenewable fuel because it takes millions of years to form.

Most coal was formed more than 300 million years ago, during the time which scientists now call the "Carboniferous Period." Special conditions, such as swampy land and warm, humid weather, allowed the coal to form over hundreds of thousands of years. As forest plants died, they fell to the swampy ground and were covered by water. There, they partly decayed, and the dead trees, shrubs, ferns, and other plants mixed together in a rich mush called **peat**.

Over the course of many years, soil and rock were deposited over the peat. The weight of these deposits squeezed water and gases from the peat, leaving carbon, a black chemical element.

Over the centuries, more material formed over the peat and the pressure increased. The peat became a kind of coal called **lignite**, which is about 30 percent carbon. Eventually, with more time and pressure, lignite becomes soft coal or **bituminous** coal, which is about 85 percent carbon. Bituminous coal is by far the most common type of coal found in the United States. In areas where additional pressure combined with the very high temperature inside the earth, soft coal became hard coal, or **anthracite**, which is almost all carbon.



Over the course of millions of years, rich, mushy peat – which was formed from decayed plants – was changed into coal, a carbon-rich fossil fuel.

History of Coal in America

As a young nation, America lagged behind England and other European countries in producing and using coal. Instead of coal, Americans used water and wood power to heat their homes and fuel their small industries. But as wood became scarce in the early 1800's, Americans began to substitute coal for water and wood power. The growing American railroad system also allowed for the easy transportation of coal.

Demand for coal continued to grow and by 1920 coal was America's number one source of energy. Coal remained king until 1952 when petroleum (oil) became the most-used energy source. Today coal provides about 30 percent of America's energy needs.

Coal Reserves and Coal Production

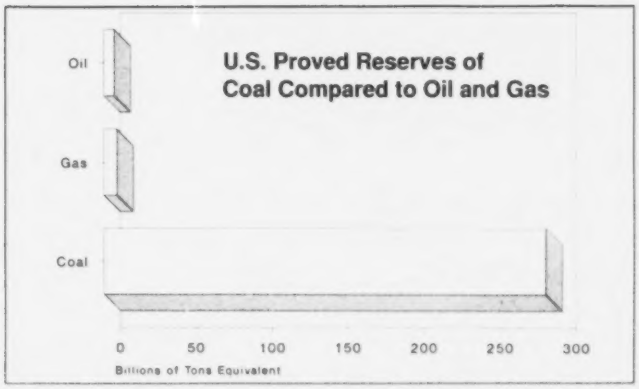
When scientists estimate how much coal, oil, natural gas, etc. the United States has, they use the term **reserves**. Coal reserves are beds of coal still in the ground waiting to be mined. The United States has the world's largest known coal reserves. If we continue to use coal at the rate it was used in 1989, we have enough coal to last about 300 years.

Where is most of the coal in the United States found? The state of Montana has the most coal reserves. It is followed by Illinois, Wyoming, Kentucky, and West Virginia.

Coal **production** is the amount of coal that is actually mined and sent to market. Coal is mined in more than 27 states. In 1989, Wyoming mined the most coal, followed by Kentucky, West Virginia, Pennsylvania, and Illinois.

Coal Mining

There are two methods used to remove coal from the ground: surface mining and underground mining.



The Unites States has about a 300-year supply of coal. Supplies of oil and natural gas are much smaller. Graphic courtesy of U.S. Dept. of Energy.

Surface mining is the method used most often to remove coal from the ground. This method can be used when the coal is buried less than 200 feet underground. In surface mining, giant machines remove the topsoil and underlying layers of rock to expose large beds of coal. Once the mining is finished, the dirt and rock are returned to the pit, the topsoil is replaced, and the area is seeded. The land can then be used for croplands, wildlife habitats, recreation, or commercial development.

Underground mining is the method used when the coal is buried deep within the earth. Some underground coal mines sink 2,000 feet deep! To extract coal in underground mines, a deep shaft is dug into the earth with tunnels branching from it. Miners go down the shaft into the tunnels and operate machines to remove the coal.

Processing and Transporting Coal

After coal is mined, it is taken to a special plant, called a processing plant, where it is cleaned. At the plant, rock, ash, sulfur and other loose impurities are washed out ot the coal. Cleaning the coal improves its heating value.

Once the coal is cleaned, it is ready to go to market. Long trains are used to transport most of the coal to market. Sometimes river barges, trucks, and conveyor belts are also used to transport coal. In one place, coal is even crushed and mixed with water for transport by pipeline.

How Coal Is Used

Most coal today is used to make electricity. In fact, more than half of the electricity produced in the U.S. is made from coal. Some electric power plants are even located at coal mine sites in order to lower the cost of transporting coal over long distances.

The steel and iron industries are also big users of coal. They use it as a fuel for making metals.

American coal is also used in other countries. The United States exports ten percent of its coal to other countries.

On the other hand, very little coal is used anymore for heating homes and businesses. Instead, coal furnaces have largely been replaced by natural gas or electric furnaces.

Coal and the Environment

When the nation first started using coal, Americans were not very concerned about their environment. For years, smokestacks from factories released dirty fumes into the air while coal mining left some areas barren and destroyed. As time went by, Americans began to notice how their environment was suffering. Today, America wants to balance the needs of industry and the environment.

The coal industry is now working on ways to make coal cleaner. People in the industry believe that removing most of the sulfur and carbon in the coal before it is burned will help reduce air pollution. When coal is burned, a chemical called sulfur is released into the air where it combines with oxygen to form sulfur dioxide. Sulfur dioxide has been linked to **acid rain**, a condition which has harmful effects on wildlife (especially fish) and forests. The coal industry now uses "scrubbers" to remove most of the sulfur from coal.

The industry is also concerned about the carbon that is released into the air when coal is burned. Carbon reacts with oxygen in the air to form carbon dioxide. This gas, along with the gases from automobiles and aerosol cans, collect in the earth's atmosphere where they form a shield which lets the sun's heat in, but doesn't let it out. This condition is called the **greenhouse effect.**

Printed on recycled paper

Energy Fact Sheet: Coal

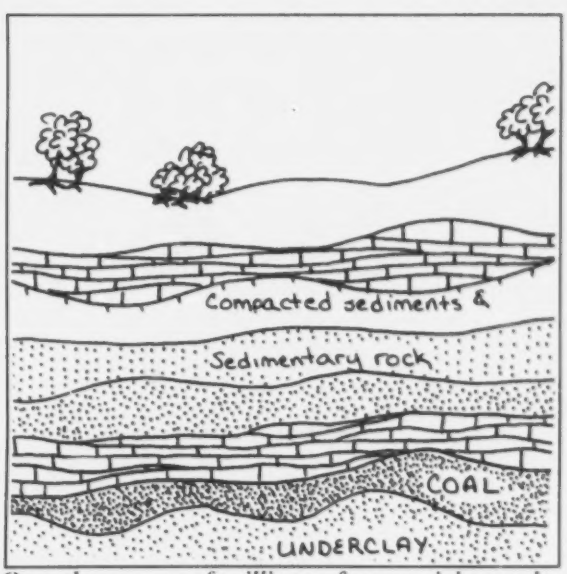
What Is Coal?

Coal is a nonrenewable fossil fuel that was formed from the remains of ancient plants. It's called a nonrenewable fuel because it takes millions of years to form.

Most coal was formed more than 300 million years ago, during the time which scientists now call the "Carboniferous Period." Special conditions, such as swampy land and warm, humid weather, allowed the coal to form over hundreds of thousands of years. As forest plants died, they fell to the swampy ground and were covered by water. There, they partly decayed, and the dead trees, shrubs, ferns, and other plants mixed together in a rich mush called **peat**.

Over the course of many years, soil and rock were deposited over the peat. The weight of these deposits squeezed water and gases from the peat, leaving carbon, a black chemical element.

Over the centuries, more material formed over the peat and the pressure increased. The peat became a kind of coal called **lignite**, which is about 30 percent carbon. Eventually, with more time and pressure, lignite becomes soft coal or **bituminous** coal, which is about 85 percent carbon. Bituminous coal is by far the most common type of coal found in the United States. In areas where additional pressure combined with the very high temperature inside the earth, soft coal became hard coal, or **anthracite**, which is almost all carbon.



Over the course of millions of years, rich, mushy peat – which was formed from decayed plants – was changed into coal, a carbon-rich fossil fuel.

History of Coal in America

As a young nation, America lagged behind England and other European countries in producing and using coal. Instead of coal, Americans used water and wood power to heat their homes and fuel their small industries. But as wood became scarce in the early 1800's, Americans began to substitute coal for water and wood power. The growing American railroad system also allowed for the easy transportation of coal.

Demand for coal continued to grow and by 1920 coal was America's number one source of energy. Coal remained king until 1952 when petroleum (oil) became the most-used energy source. Today coal provides about 30 percent of America's energy needs.

Coal Reserves and Coal Production

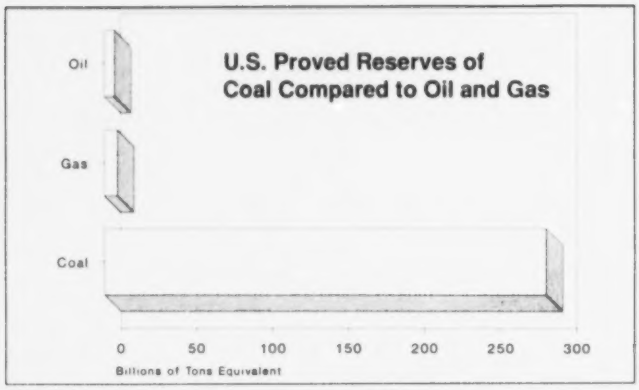
When scientists estimate how much coal, oil, natural gas, etc. the United States has, they use the term **reserves**. Coal reserves are beds of coal still in the ground waiting to be mined. The United States has the world's largest known coal reserves. If we continue to use coal at the rate it was used in 1989, we have enough coal to last about 300 years.

Where is most of the coal in the United States found? The state of Montana has the most coal reserves. It is followed by Illinois, Wyoming, Kentucky, and West Virginia.

Coal **production** is the amount of coal that is actually mined and sent to market. Coal is mined in more than 27 states. In 1989, Wyoming mined the most coal, followed by Kentucky, West Virginia, Pennsylvania, and Illinois.

Coal Mining

There are two methods used to remove coal from the ground: surface mining and underground mining.



The Unites States has about a 300-year supply of coal. Supplies of oil and natural gas are much smaller. Graphic courtesy of U.S. Dept. of Energy.

Surface mining is the method used most often to remove coal from the ground. This method can be used when the coal is buried less than 200 feet underground. In surface mining, giant machines remove the topsoil and underlying layers of rock to expose large beds of coal. Once the mining is finished, the dirt and rock are returned to the pit, the topsoil is replaced, and the area is seeded. The land can then be used for croplands, wildlife habitats, recreation, or commercial development.

Underground mining is the method used when the coal is buried deep within the earth. Some underground coal mines sink 2,000 feet deep! To extract coal in underground mines, a deep shaft is dug into the earth with tunnels branching from it. Miners go down the shaft into the tunnels and operate machines to remove the coal.

Processing and Transporting Coal

After coal is mined, it is taken to a special plant, called a processing plant, where it is cleaned. At the plant, rock, ash, sulfur and other loose impurities are washed out ot the coal. Cleaning the coal improves its heating value.

Once the coal is cleaned, it is ready to go to market. Long trains are used to transport most of the coal to market. Sometimes river barges, trucks, and conveyor belts are also used to transport coal. In one place, coal is even crushed and mixed with water for transport by pipeline.

How Coal Is Used

Most coal today is used to make electricity. In fact, more than half of the electricity produced in the U.S. is made from coal. Some electric power plants are even located at coal mine sites in order to lower the cost of transporting coal over long distances.

The steel and iron industries are also big users of coal. They use it as a fuel for making metals.

American coal is also used in other countries. The United States exports ten percent of its coal to other countries.

On the other hand, very little coal is used anymore for heating homes and businesses. Instead, coal furnaces have largely been replaced by natural gas or electric furnaces.

Coal and the Environment

When the nation first started using coal, Americans were not very concerned about their environment. For years, smokestacks from factories released dirty fumes into the air while coal mining left some areas barren and destroyed. As time went by, Americans began to notice how their environment was suffering. Today, America wants to balance the needs of industry and the environment.

The coal industry is now working on ways to make coal cleaner. People in the industry believe that removing most of the sulfur and carbon in the coal before it is burned will help reduce air pollution. When coal is burned, a chemical called sulfur is released into the air where it combines with oxygen to form sulfur dioxide. Sulfur dioxide has been linked to **acid rain**, a condition which has harmful effects on wildlife (especially fish) and forests. The coal industry now uses "scrubbers" to remove most of the sulfur from coal.

The industry is also concerned about the carbon that is released into the air when coal is burned. Carbon reacts with oxygen in the air to form carbon dioxide. This gas, along with the gases from automobiles and aerosol cans, collect in the earth's atmosphere where they form a shield which lets the sun's heat in, but doesn't let it out. This condition is called the **greenhouse effect.**

Energy Fact Sheet: Biomass

What Is Biomass?

Biomass is a renewable source of energy that is a result of solar energy. Energy from the sun is stored in plant matter – trees, crops, seaweed, algae – and in animal waste. The solar energy stored in biomass can be released in four different ways: 1) burning; 2) bacterial decay; 3) conversion to gas or liquid fuel; and 4) fermentation.

Burning

The easiest way to release biomass energy is by burning it. Wood, for example, has been burned for thousands of years for heating and cooking. Until the mid-1800's, wood provided almost all of the United States' energy. Today, five percent, or one out of every 20 homes, uses wood as their main heating fuel.

Garbage can also be burned to generate electricity if it is **organic**. That means if it was once living matter. Food waste is organic material. So is paper because it is made from wood pulp.

Other organic waste products such as wood shavings, fruit pits, manure, corn cobs, walnut shells, straw, and corn stalks can be also be burned to release stored solar energy.

Bacterial Decay

Another way to release biomass energy is to combine it with bacteria which will cause it to decay quickly. As the biomass decays, a gas is naturally produced. This gas is called **methane**. In some landfills where garbage is buried, wells are drilled to capture the methane produced from decaying waste.

Conversion

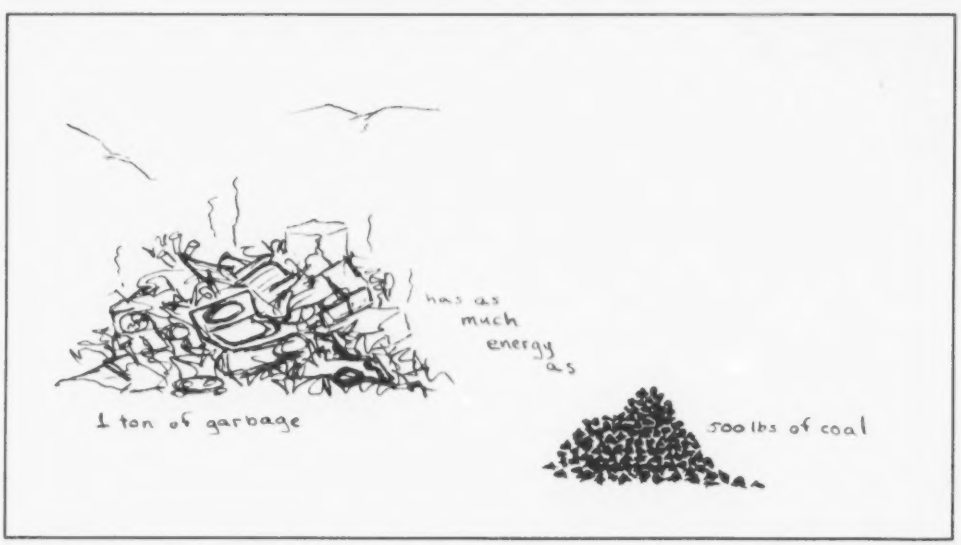
A third way to convert biomass into energy is by changing it into a gas or liquid fuel. This is done by adding heat or chemicals to the biomass. The gas or liquid fuel can then be used to produce heat or electricity, or it can be used as a fuel for automobiles. In India, for example, manure is converted to methane gas to provide that country with heat and light.

Fermentation

A final way to convert biomass into energy is fermentation. In fermentation a yeast is added to biomass producing a fuel known as ethyl alcohol or **ethanol**. For centuries, ethanol has been used as an agent in making beer, wine, and liquor. Wheat, corn, and other crops can be used to make ethanol. Typically, though, corn is used.

Today, ethanol is sometimes mixed with gasoline to produce a fuel called **gasohol**. In order for cars to run on pure ethanol, their engines would have to undergo certain changes. But cars are able to run on gasohol without changing their engines.

Converting biomass into energy sounds like a great idea. Besides producing energy, biomass also provides a use for waste materials that would otherwise be buried at landfills. In our country, many landfills are almost full, and new landfills would be expensive to build.



Garbage can be burned to produce electricity. In fact, a ton of garbage has as much energy as 500 pounds of coal.

Printed on recycled paper

Energy Fact Sheet: Geothermal

What Is Geothermal Energy?

Geothermal energy is a renewable source of energy that comes from the heat deep within the earth. The word geothermal comes from the Greek words *geo* (earth) and *therme* (heat).

Geothermal energy is generated in the earth's **core**, almost 4,000 miles beneath the earth's surface. The double-layered core is made up of very hot **magma** (molten iron) surrounding a solid iron center. Red hot temperatures are continuously produced inside the earth by the slow decay of radioactive particles that is natural in all rocks.

Surrounding the core is the **mantle**, which is about 1,800 miles thick and made up of magma and rock. The outermost layer of the earth, the land that forms the continents and ocean floors, is called the **crust**. The crust varies from about three to five miles thick under the oceans to as much as 15 to 35 miles thick on the continents.

The crust is not one solid piece, like the shell of an egg, but is broken into many pieces called **plates**. Magma comes to, or very close to, the earth's surface near the edges of these plates. This is where volcanos occur. The lava that erupts from volcanos is partly magma. Deep underground, the rocks and water absorb the heat from this magma. The heated water is pumped to the surface using geothermal wells. People around the world use geothermal energy to produce electricity, heat buildings, and for other purposes.

Geothermal energy is considered a renewable energy source because the water is replenished by rainfall and the heat is continuously regenerated deep within the earth.

History of Geothermal Energy

Geothermal energy was used by many ancient peoples for heating and bathing. Even today, hot springs are used worldwide for bathing, and many people believe hot mineral waters have natural healing powers.

The use of geothermal energy to produce electricity is a new industry. It was first attempted in Italy in 1904. The first successful geothermal energy plant in the United States began operating in 1960 at the Geysers in northern California. There are now 64 power plants producing electricity at 18 locations in the western United States.

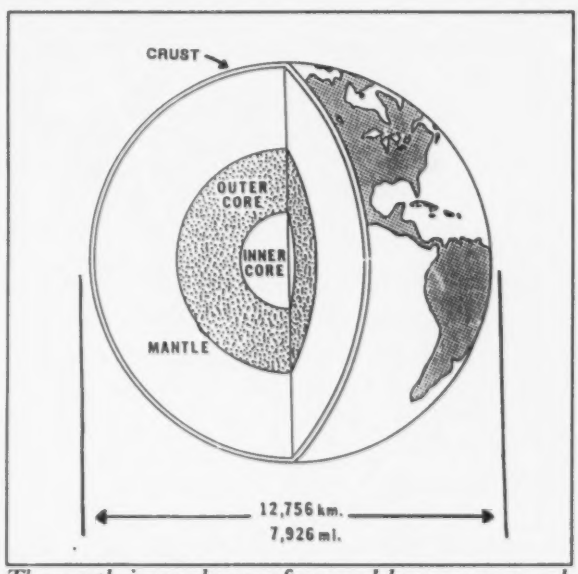
Where Geothermal Energy Is Found

Most of the geothermal activity in the world occurs in what is called the "Ring of Fire." This is an area that rims the Pacific Ocean. The best known geothermal resources are found in the Pacific regions of the United States and Mexico, and in the Philippines, New Zealand, Japan, and Indonesia, as well as in Iceland and Italy.

Some of the visible features of geothermal energy are volcanoes, hot springs, geysers, and fumaroles. But most geothermal resources are not visible. They are deep underground, and geologists use different methods to try to find them. The only way to be sure if there are geothermal resources is to drill a well and test the temperature deep underground.

Today's Geothermal Energy: Hydrothermal Resources

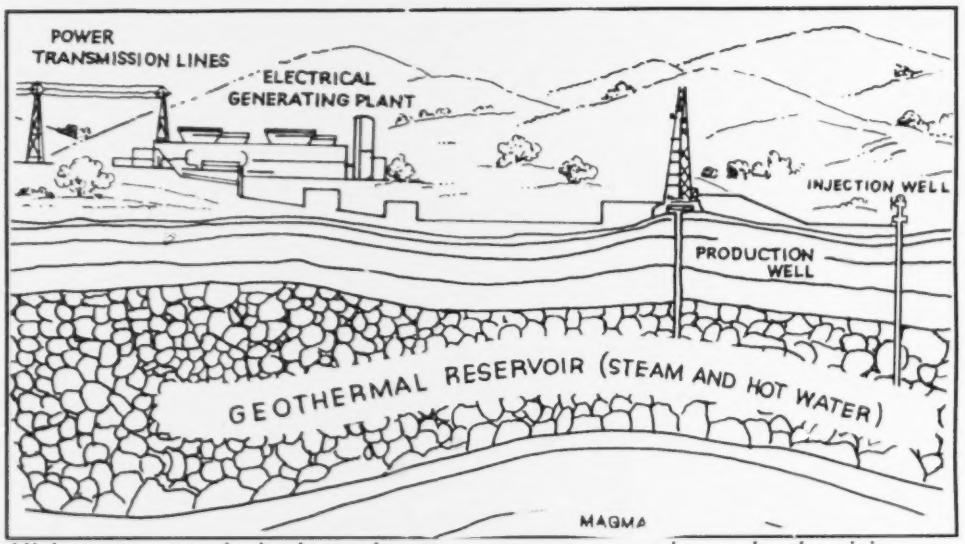
There are four kinds of geothermal energy – hydrothermal, geopressured, hot dry rock, and magma. Hydrothermal ener-



The earth is made up of several layers surrounding a solid iron core.

gy is the kind in wide use. Scientists are still studying ways to use the other three geothermal energy sources to make electricity.

Hydrothermal energy resources have two common ingredients: water (*hydro*) and heat (*therme*). Hydrothermal reservoirs are formed when magma heats the water in porous or fractured rocks deep underground.



High-temperature hydrothermal energy resources are used to make electricity.

Depending on the temperature of the hydrothermal resource, the heat energy can either be used for making electricity or for direct heating purposes.

Low Temperatures: Direct Use

Hydrothermal resources at low temperatures (50 to 300 degrees Fahrenheit) are used for heating homes and buildings, growing crops, and drying lumber, fruits, and vegetables. Here in the United States, geothermal heat pumps are used to heat and cool homes and public buildings in 45 states.

Entire districts are heated with geothermal energy in Klamath Falls, Oregon and Boise, Idaho. In other places in the world, over 500,000 people near Paris, France and most of the population of Iceland use geothermal energy to heat their homes and buildings.

High Temperatures: Generating Electricity

Hydrothermal resources at high temperatures (300 to 700 degrees Fahrenheit) can be used to produce electricity. These resources may come from either **dry steam** wells or **hot water** wells. We can reach these resources by drilling wells into the earth and piping the steam or hot water to the surface. Geothermal wells range from one to two miles deep.

In a dry steam power plant, the steam from the geothermal reservoir is piped directly from a well to a turbine generator to produce electricity. In a hot water plant, the hot water is directed to one or more separators where part of the water *flashes* into steam. From there, the steam powers a turbine generator to produce electricity just as in a dry steam plant. When the steam cools, it condenses to water and is injected back into the geothermal reservoir to be used over and over again.

Last year, hydrothermal energy produced 11 billion kilowatt hours of electricity, or about 1/2 of one percent of all the electricity produced in this country. That was enough electricity to power over three million homes.

Geothermal Energy and the Environment

Compared to other energy sources, geothermal energy does little damage to the environment. Most power plants have to transport their fuel to the plant site, but geothermal plants sit on top of their fuel source. Geothermal power plants have been built in deserts, in the middle of crops, and in mountain forests.

Motor vehicles and fossil fuel (coal, oil) power plants are the major producers of the air emissions that cause global warming and acid rain. But geothermal power plants produce almost none of these emissions.

The use of geothermal energy is growing worldwide because it costs about the same as energy from coal, it's reliable, and it doesn't burn any fuel.

NEED would like to thank the Geothermal Education Office for its assistance in producing this fact sheet.

Energy Fact Sheet: Hydropower

What is Hydropower?

Hydropower (from *hydro* meaning water) is a renewable source of energy that is obtained from the movement of water. The fall and flow of water is part of continuous natural cycle. The sun draws moisture up from the oceans and rivers, and this moisture condenses into clouds. The moisture is released from the clouds in the form of rain or snow. The oceans and rivers are thus replenished with moisture, and the cycle starts up again.

Gravity causes the water in rivers and streams to move from places of higher ground to places of lower ground. The force of moving water can be quite great. Anyone who has been white water rafting knows that!

History of Hydropower

One of the oldest methods of using renewable energy resources is the water wheel. The water wheel picks up water in buckets located around the wheel, and the dead weight of the water causes the wheel to turn. Thus the **kinetic energy** (energy pertaining to motion) of the water is converted into **mechanical energy** to grind grain or drive sawmills.

Water wheels have been in use for centuries; the Greeks used water wheels to grind wheat into flour over 2000 years ago. In both the U.S. and Europe, industrial plants in the early 1800's used the water wheel to power machines.

In the latter part of the 19th century, falling water was first used to generate electricity. Hydroelectric power plants were built at the sites of waterfalls and dams. A hydroelectric plant was built at Niagara Falls in 1879.

In the following decades many more plants were built. At their height in the 1940's, hydroelectric plants provided 33 percent of this country's electricity. But after that, the best sites for large dams were already developed, so few new dams were built. Also, fossil fuels like coal and oil became inexpensive so even the smaller hydropower plants were more expensive to operate than those powered by fossil fuels. Not until the oil embargo of 1973 did people once more become interested in hydropower.

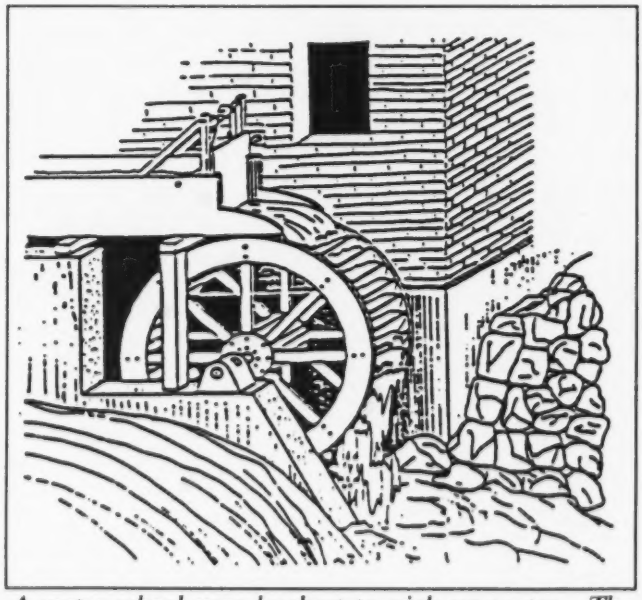
Hydroelectric Plants

As people discovered centuries ago, the flow of water represents a huge supply of energy which can be tapped in order to do work. While water wheels are useful for generating mechanical energy to grind grain or saw wood, they are not practical for generating electricity because of their bulky structures and slow speeds. Instead, hydroelectic plants – like thermal (coal, nuclear) power plants – rely on turbine generators to produce electricity.

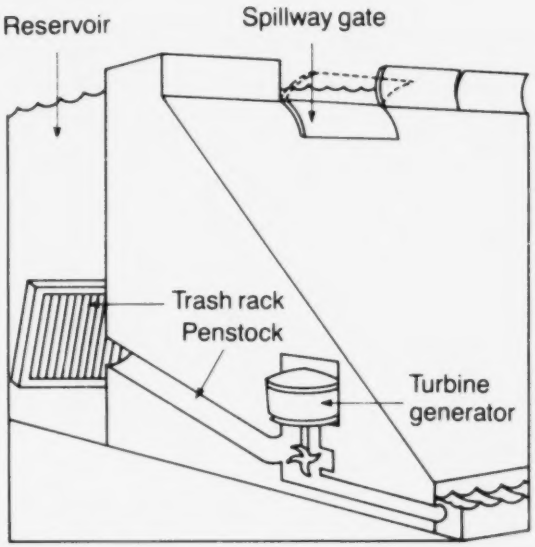
How Electricity Is Produced

In hydropower plants, the force of gravity pulls water down a large tube called a **penstock**. At the bottom of the penstock, the fast-moving water spins the blades of a **turbine** which is attached to a generator to produce electricity. The electricity is then transported along huge transmission lines to a utility company which distributes it to customers.

If there isn't a natural waterfall in the area, a dam may be built to "pen in" a large amount of water. A **reservoir** is the artificial lake created by damming a river. A dam controls the flow of water



A water wheel uses buckest to pick up water. The weight of the water then causes the wheel to turn.



Water rushing down through penstocks turns a turbine generator which produces electricity. Trash racks prevent reservoir debris from entering the penstocks and fouling up the turbines. Spillway gates release excess water from the reservoir during periods of heavy rainfall. Source: Electric Power Research Institute

from the reservoir and increases elevation for a higher waterfall.

The ability to store water is one of the biggest advantages of a hydroelectric power plant. Water can be stored or released depending on how much electricity is needed. For example, during the night when people use less electricity, water can be held back in the reservoir. Then, during the day when people use more electricity, water can flow through the plant to generate electricity.

There are also some very small hydropower plants which do not rely on dams or reservoirs to generate electricity. Instead, these **"run of the river"** plants depend entirely on a river's constant flow of water to meet power needs.

Hydropower Production and Cost

How much electricity do we get from hydropower? Quite a bit. Depending on whether the year has been rainy or dry, hydropower provides anywhere from eight to 14 percent of this country's electricity. In three states – Idaho, Oregon, and Washington – hydropower supplies over 85 percent of the electricity each year.

Hydropower is also the *cheapest* way to generate electricity in the United States today. For one thing, the sturdy structures and relatively simple equipment of a hydroplant are dependable and long-lived, and maintenance costs are low compared to other plants. But mostly, electricity generation costs are low because the energy source – flowing water – is free of charge.

What will the future hold for hydropower? First of all, several kinds of improvements can be made at existing hydro plants to increase the amount of electricity they generate. Next, dams that were built solely for flood control and irrigation could be converted to produce electricity. Currently, only three percent of the 63,000 dams in the U.S. have power-generating facilities.

Hydropower and the Environment

Hydropower does present a few environmental problems. For one thing, damming rivers can disturb or destroy the wildlife and natural resources of an area. Farms, homes, highways, railroads, and sometimes whole towns may have to be moved because once a dam is built, the river behind it will flood the countryside.

On the plus side, hydropower's fuel supply (flowing water) is clean and is renewed yearly by snow and rainfall. Unlike fossil fuel plants, hydroelectric plants do not emit any pollutants because they burn no fuel. Hydropower is also the only energy source that offers a whole range of added benefits, e.g., flood control, water supply, irrigation, and recreation (boating, fishing, swimming).

NEED would like to thank the National Hydropower Association for its assistance in producing this fact sheet.

Energy Fact Sheet: Natural Gas

What Is Natural Gas?

Natural gas is generally considered a nonrenewable fossil fuel. (There are some renewable sources of natural gas.) Natural gas is called a fossil fuel because most scientists believe that natural gas was formed from the remains of ancient sea plants and animals.

When the plants and tiny sea animals died, they sank to the bottom of the oceans where they were buried by sand and rock. The layers of sand, rock, and plant and animal matter continued to build up until the pressure and heat from the earth turned them into petroleum (oil) and natural gas.

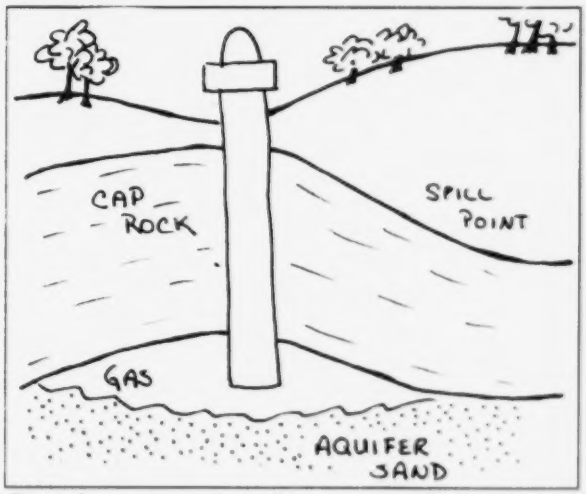
Natural gas is really a mixture of gases trapped in underground rocks much like a wet household sponge traps water. The main ingredient in natural gas is **methane**. By itself, methane has no color, odor, or taste. As a safety measure, natural gas utility companies add an odorant to the gas so that leaking gas can be detected. Natural gas should not be confused with gasoline which is made from petroleum.

History of Natural Gas

People have known about natural gas for thousands of years. The ancient Chinese burned natural gas to evaporate sea water in salt making. Almost 200 years ago the streets of Genoa, Italy, were lighted by natural gas. In 1821, the United States' first successful natural gas well was dug in Fredonia, New York, by William Hart. Today, natural gas supplies about a quarter of all the energy we use in the United States.

Measuring Natural Gas

Gasoline is sold in gallons, coal in pounds, and wood in cords. Natural gas, on the other hand, is sold in cubic feet. But the heat energy that is stored in gasoline, coal, wood, or natural gas can all be measured by one common unit of measure. That common measure is **British thermal units** or **Btu's**. A burning kitchen match releases about one Btu. A cubic foot of gas has about 1,031 Btu.



Over time, natural gas became trapped in porous rock much like a wet household sponge holds water.

The Natural Gas Industry

The natural gas industry is made up of three parts: the natural gas producer; the pipeline company; and the local gas utility.

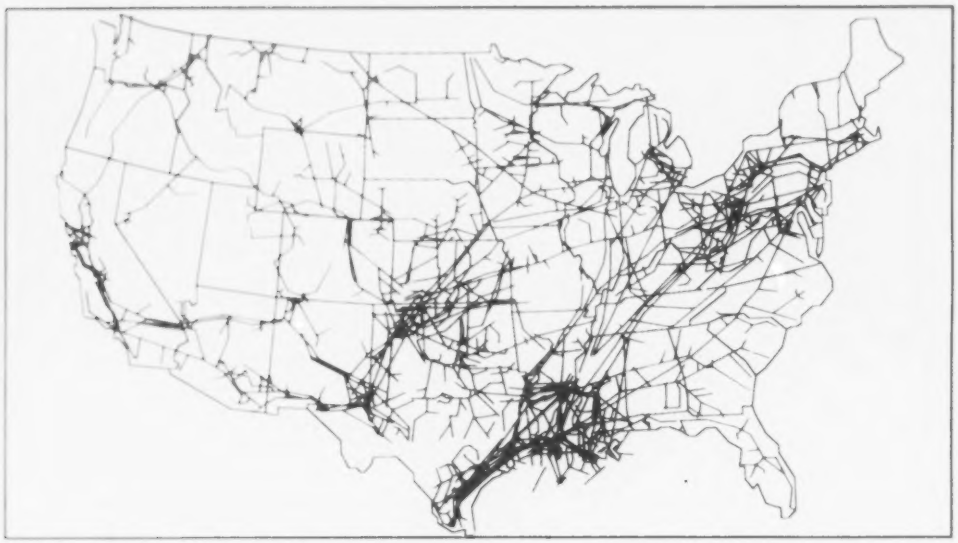
The **natural gas producer** is the company which explores, drills, and takes the natural gas out of the ground. Sometimes wells are drilled only to find that no natural gas is located there. Natural gas wells average over one mile deep!

The **pipeline company** brings the natural gas to the local utility company. Gas is delivered all over the country by way of an underground pipeline system. The gas can travel 500 miles per day.

The **local gas utility** brings the gas from the pipeline company and distributes it to the homes, businesses, and industries in your area. It sends customers a monthly bill which shows how much gas was used during the month and how much it cost.

Natural Gas Resources

Natural gas **resources** are deposits of gas in the ground waiting to be tapped. The United States has large resources of natural gas. States with the largest resources are Texas, Alaska, Oklahoma, Louisiana, and New Mexico. Large resourcess are also located offshore in the Gulf of Mexico and the Mobile Bay. Given today's prices and drilling technology, scientists estimate that the



A huge underground pipeline networks exists to move natural gas to the user. Illustration courtesy of American Gas Association.

United States has about a 50-year supply of natural gas. Another 200-year supply of natural gas could be produced if consumers are willing to pay more for the gas they use.

Who Uses Natural Gas?

Natural gas supplied the United States with about one quarter of its energy needs in 1989. It was the third leading supplier of the nation's energy, after petroleum and coal.

Industry was the biggest user of natural gas. Industry uses it to provide heat to manufacture goods. Industry also uses natural gas as an ingredient in fertilizer, glue, paint, laundry detergents, and other items.

Natural gas is also used to heat homes and businesses. In fact, it is used to heat over half the homes in this country. About 60 million homes use gas for heating, hot water, and cooking.

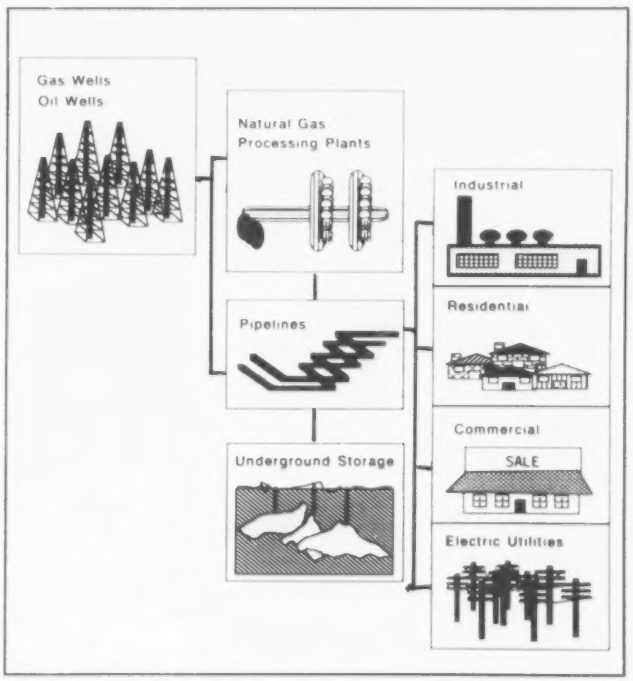
Electric utility companies also use natural gas to produce electricity. Last year, natural gas was used to make about 10 percent of the nation's electricity.

To a small degree, natural gas is even used as a fuel for running automobiles, trucks, and buses!

Natural Gas and the Environment

All the fossil fuels – coal, petroleum, and natural gas – release pollutants into the air when they are burned to provide the energy we need. Three major environmental problems can be traced to the burning of these fossil fuels: acid rain; the greenhouse effect; and urban smog.

The good news is that natural gas is by far the most clean-burning of the fossil fuels. Compared to coal and oil, natural gas releases much less sulfur, carbon, and nitrogen compounds when it's burned and less fly ash. Because natural gas is such a clean source of energy, scientists are looking for new sources of natural gas and new ways to use it.



Natural gas is pumped out of the ground, processed at a plant, and then sold to users. Illustration courtesy of U.S. Dept. of Energy.

The NEED Project would like to thank the American Gas Association for its assistance in producing this fact sheet.

Energy Fact Sheet: Petroleum

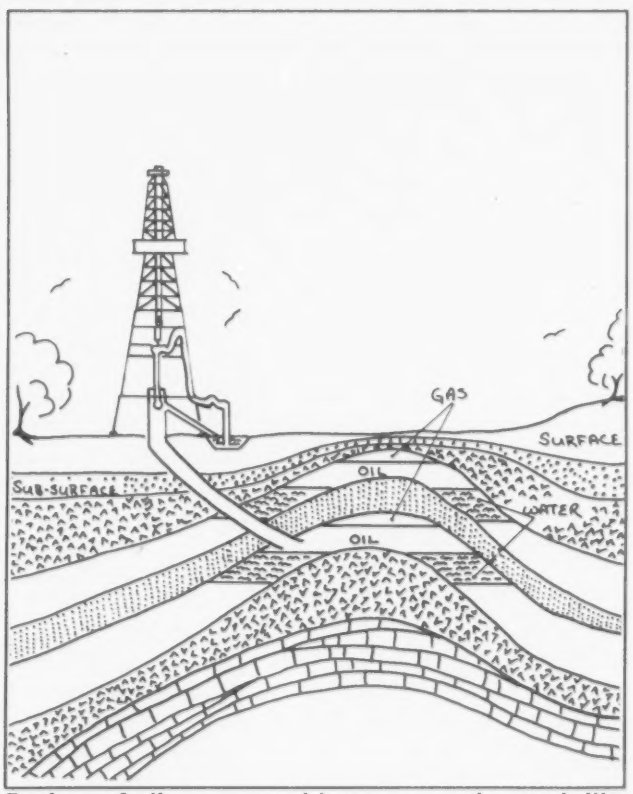
What Is Petroleum?

Petroleum, also called crude oil, is a non-renewable fossil fuel. It's called a fossil fuel because it was formed from the remains of tiny sea plants and animals that died millions of years ago.

When the plants and animals died, they sank to the bottom of the oceans. Here, they were buried by thousands of feet of sand and silt. As the layers increased, they pressed harder and harder on the decayed remains at the bottom. The heat and pressure changed the remains and, eventually, petroleum was formed. Petroleum is locked within rocks almost like water gets trapped in a wet household sponge. When crude oil comes out of the ground, it may be as thin as gasoline or as thick as tar.

History of Oil

People have known about petroleum since ancient times. The ancient Chinese and Egyptians burned oil for light. Before the 1850's, Americans used candles and whale oil to light their homes. When whale oil became scarce, people began skimming the oil which seeped to the surface of ponds and streams. The demand for crude oil increased, and in 1859, Edwin L. Drake drilled the first oil well near Titusville, Pennsylvania.



Pockets of oil are trapped in porous rocks much like water is trapped in a wet household sponge. Oil companies bring in drilling rigs to remove the oil from the ground. A typical oil well is nearly one mile deep.

At first the crude oil was made or **refined** into kerosene which was used for lighting. The other oil products were simply thrown away since there was no use for them. This all changed when Frank and Charles Duryea built the first American gasoline-powered automobile in 1892. Now there was another petroleum product in big demand – gasoline. Today, petroleum provides America with more energy than any other energy source.

Producing Oil

Geologists look at the type of rocks and the way they are arranged deep within the earth to determine whether oil is likely to be found at a location. Still, oil exploration is expensive and often unsuccessful. Out of every 100 wells drilled, only 36 to 40 produce oil.

The average oil well is about one mile deep, but some may sink to more than three and a half miles deep. A pump is used to move the crude oil through a pipe to the surface.

After crude oil comes out of the ground, it is taken to an oil refinery for processing. A refinery separates the petroleum into different fuels and by-products. Gasoline, diesel fuel, and heating oil are three important fuels made from crude oil. Petroleum is also used to make plastics, medicines, cosmetics, paint, rubber, and fertilizers. In all, about 6,000 products are made from petroleum today.

By far, the biggest use of petroleum is for transportation fuels – gasoline, diesel fuel, and jet fuel. About two out of every three barrels of oil is used to keep Americans on the move.

Petroleum Products

Americans consume petroleum products at a rate of 2.6 gallons of oil a day for every man, woman, and child, 365 days a year. But petroleum isn't just used as an automotive fuel. Petroleum "feedstocks" provide us with more than 6,000 products. Here are just some of them.

Ink	*Floor wax*	*Dice*	*Shoe polish*
Heart valves	*Tires*	*Trash bags*	*Food preservatives*
Crayons	*Umbrellas*	*Shampoo*	*Fertilizers*
Parachutes	*Hand lotion*	*Shaving cream*	*Insecticides*
Telephones	*Toothbrushes*	*Cameras*	*Cold cream*
Enamel	*Toothpaste*	*Dentures*	*Detergents*
Transparent tape	*Guitar strings*	*Nail polish*	*Life jackets*
Antiseptics	*Loudspeakers*	*Dashboards*	*Rollerskate wheels*
Purses	*Movie film*	*Luggage*	*Lipstick*
Deodorant	*Aspirin*	*LP records*	*Tennis rackets*
Pantyhose	*Sunglasses*	*Balloons*	*Combs*
Rubbing alcohol	*Glue*	*Paint brushes*	*Safety glass*
Oil filters	*Artificial limbs*	*Footballs*	*Artificial turf*
Pajamas	*Ballpoint pens*	*Dyes*	*Bandages*
Cassettes	*Shower curtains*	*Antihistamines*	*Roofing*
Fishing rods	*Golf balls*	*Skis*	*House paint*
Electrical tape	*Contact lenses*	*Perfumes*	*Credit cards*

Petroleum is produced in 31 of the 50 states. Texas is the leading producer. It is followed by Alaska, Louisiana, California, and Oklahoma – in that order. The largest oil producer in the world is the Soviet Union, followed by the United States, Saudi Arabia, Iran, Iraq, China and Mexico. (However, Saudi Arabia has the most *reserves* of oil still underground.)

Transporting and Storing Oil

Because most oil produced in the United States comes from areas located away from cities and towns, an oil transportation and storage system has been built over the years. Oil can be transported by pipelines, ocean-going supertankers, river barges, trains, and trucks.

Most of the crude oil produced in the United States is transported by pipeline. Petroleum products move through the pipelines at about five miles per hour. At this rate, it takes 15 days to move petroleum products from Houston, Texas to New York City. Today there are about 230,000 miles of petroleum pipelines in the United States.

Huge round storage tanks are used to store petroleum. Sites with many storage tanks are called "tank farms." Gasoline filling stations use *underground* storage tanks to hold their gasoline. Trucks deliver the gasoline to the stations and pump it to the underground tanks.

How Much Oil Do We Use?

Americans use more oil than anyone else in the world. At the rate Americans used petroleum in 1989, the United States has only enough oil to last about ten and half more years. Although it is possible that new oil fields may be discovered, we will still eventually run out of petroleum. And while we are the world's second-leading producer of oil, we still must import 46 percent of our oil from other countries to keep up with Americans' demand. Most of our imported oil comes from Saudi Arabia, Canada, Venezuela, Nigeria, and Mexico – in that order.

Oil and the Environment

Petroleum products – gasoline for cars, medicines, fertilizers, etc. – have helped people all over the world. But there is a flipside. Petroleum products cause air, water, and solid waste pollution. At every stage in bringing oil from the well to the market place, pollution is a concern.

Drilling for oil disturbs fragile land and ocean environments. Transporting oil can endanger wildlife and the environment if it's spilled on rivers and oceans. Processing oil at refineries produces air and water pollution. Leaking storage tanks pollute groundwater. Burning gasoline to fuel our cars causes air pollution. Even disposing of waste oil (for example, the oil drained from the family car) poses pollution problems if it's disposed of carelessly.

The situation is getting better though. Oil companies have cleaned up their refineries. Gasolines and heating oils have been changed to burn cleaner. And oil companies are making sure that the drilling and shipping of oil is done as safely as possible.

Printed on recycled paper

Energy Fact Sheet: Propane

What Is Propane?

Propane is a nonrewable fossil fuel that is extracted from nautral gas and petroleum after they are taken out of the ground. Propane is just one of the many fuels that are included in the **liquefied petroleum (LP) gas** family. But because propane is the most common type of LP gas, "propane" and "LP-gas" are often used to mean the same thing.

Just like water can be a liquid or a gas (steam), propane can be either a liquid or a gas. Under normal conditions, propane is a gas. But under certain conditions (lower temperatures, for example), propane becomes a liquid. Propane is stored as a liquid fuel because it takes up a lot less space in that form. It becomes a gas again when it is released from its storage container to fuel appliances and equipment.

Its closest cousin is natural gas. Like natural gas, propane is colorless and odorless. For this reason, an odor is added to propane so that escaping gas can be detected. Also like natural gas, propane is a very clean energy source compared to other fossil fuels such as coal and petroleum.

History of Propane

Propane gas wasn't discovered until 1911. Its discovery was a result of an effort to solve a problem with gasoline which evaporated when stored. An American scientist, Dr. Walter Snelling, discovered that several of the evaporating gases could be changed into a liquid and stored at moderate pressure. The most plentiful of these gases was propane. Just one year later, the commercial propane industry began, heating the first American home with propane.

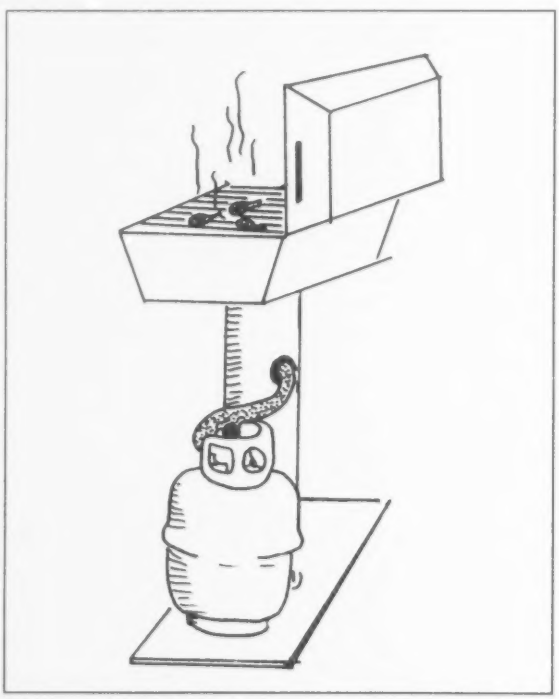
Producing Propane

Propane is mixed with natural gas and petroleum deposits that are in the ground. When natural gas and petroleum are cleaned and processed, propane is something that is separated out. Raw natural gas is about 90 percent methane, about five percent propane, and about five percent other gases. The propane is separated from the other gases at the processing plant. Likewise, when petroleum is refined, it produces gasoline, heating oil, jet fuel, propane, and other products.

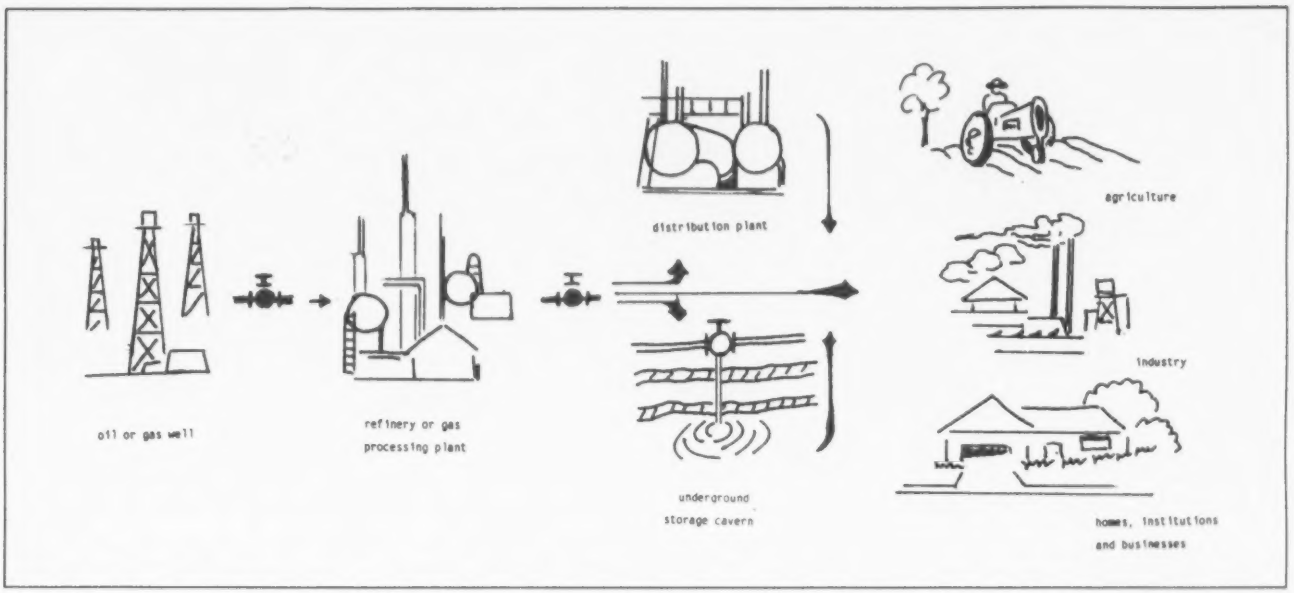
Transporting Propane

How does propane get from natural gas processing plants or oil refineries to the consumer? Propane is usually moved through pipelines to bulk storage plants (also called distribution plants) located across the nation. Bulk storage plants are like warehouses which store merchandise before shipping it to stores and shops. Propane is also moved via railroad, trucks, barges, and supertankers. Propane can also be stored in large underground caverns until it is ready to be used.

The local propane dealer supplies homes and businesses with propane in two ways. For larger consumers, the dealer sends a truck to fill the consumer's propane tank which may be located either above or below the ground. For smaller consumers, the dealer delivers cylinders of propane to the consumer. (Consumers who use very little propane – backyard barbecue cooks, for example – must bring their propane cylinders to the dealer to be filled.)



The cooking fuel for many barbecue grills is propane, not charcoal.



How Propane gets from the well to the consumer: *1) Propane comes from either an oil or natural gas well. 2) Propane is separated out at an oil refinery or gas processing plant. 3) Next, propane is sent to a distribution plant or stored in underground caverns. 4) Finally, propane is delivered to the consumer.*

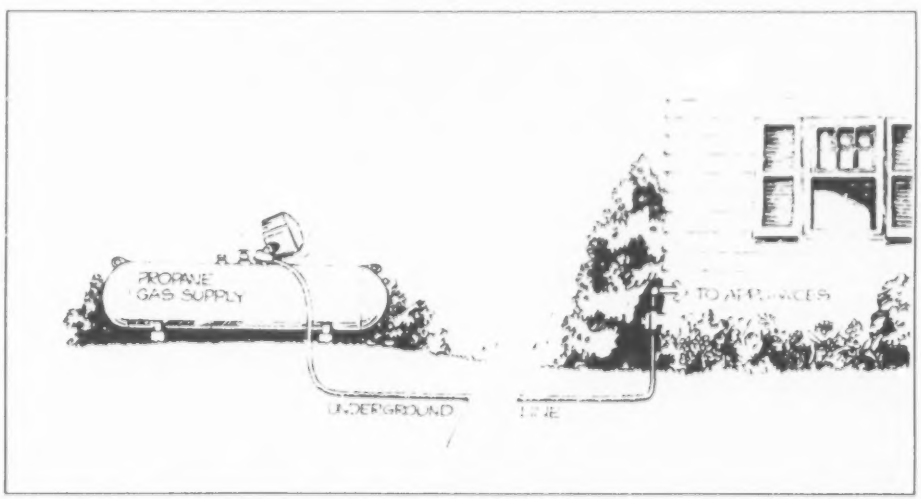
How Propane Is Used

Propane is mostly used in areas which do not have natural gas service. Homes and businesses use propane for heating, hot water, cooking, and clothes drying. Many families have barbecue grills that are fueled by propane gas. Some families have recreational vehicles equipped with propane appliances.

Half of America's farms also rely on propane to meet their energy needs. Propane has long been used by farmers to dry crops, power tractors, heat greenhouses, and to keep chicken houses warm.

Certain industries have found propane well-suited to their special needs. Metal workers use small propane tanks to fuel cutting torches. Portable propane heaters give construction and road workers warmth in cold weather. Propane is also used to heat asphalt for highway construction and repairs. And because propane burns so cleanly, forklift trucks powered by this fuel can operate safely inside factories and warehouses.

Propane is also used as a transportation fuel. Taxicab companies, government agencies, and school districts often use propane to fuel their vehicles. Propane is clean-burning, leaving automobile engines free of deposits that can age an engine quickly. It also emits less pollutants into the air than gasoline.



Some homeowners have propane gas tanks. The propane is brought into the house by underground pipelines to fuel appliances.

Printed on recycled paper

Energy Fact Sheet: Solar Energy

What Is Solar Energy?

Every day the sun radiates, or sends out, an enormous amount of energy. In fact it radiates more energy in one second than people have used since time began.

Where does all this energy come from? It comes from within the sun itself. Like most stars, the sun is a big gas ball made up mostly of hydrogen and helium gas. Solar energy is created in the center of the sun in a process called **nuclear fusion**.

During nuclear fusion, the sun's extremely high pressure and hot temperature (more than 20 million degrees Fahrenheit!) cause the hydrogen atoms to come apart and their nuclei (the central cores) to *fuse* or combine together. Four hydrogen nuclei fuse to form one helium atom. But the helium weighs less than the four nuclei that combined to form it. Some matter is lost during nuclear fusion. That lost matter is emitted into space as radiant (solar) energy.

Only a small part of the solar energy that the sun gives up ever reaches earth, but that is more than enough to supply all our energy needs. In fact, enough solar energy reaches the earth in just one day to supply our nation's energy needs for one and a half years! It takes the sun's energy just a little over eight minutes to travel the 93 million miles to earth. The solar energy travels to earth at a speed of 186,000 miles per second, the speed of light.

Heating with Solar Energy

Today, solar energy is used for both heating and producing electricity. But using solar energy for heating is probably the most popular use. Solar energy can be used to heat homes and buildings or to heat water.

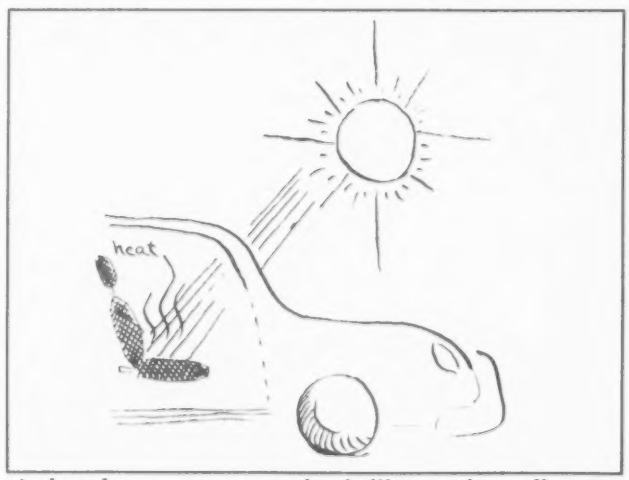
Still, capturing sunlight and putting it to work is difficult. A **solar collector** is one way to capture sunlight and change into usable heat energy. A closed car on a sunny day is like a solar collector. As sunlight passes through the car's windows, it is absorbed by the seat covers, walls, and floors of the car. The absorbed light changes into heat. The car's windows let light in, but they don't let all the heat out.

So, a solar collector does three things: 1) it allows sunlight in; 2) it absorbs the sunlight and changes it into heat energy; and 3) it traps most of the heat.

Solar Space Heating: Solar Homes

Today many homes are heated by solar energy. A **passive** solar home is designed to let in as much sunlight as possible. It is like a big solar collector. Sunlight passes through the house's windows and heats the walls and floors inside the house. The light can get in, but it is trapped inside when it changes into heat energy. A solar home is called "passive" because it does not depend on mechanical equipment, such as pumps and blowers, to heat the house.

An **active** solar home, on the other hand, uses special equipment to help heat the house. In one of its simplest forms, an active solar house uses special collectors that look like boxes covered with glass. These collectors are mounted on the house's rooftop facing south to take advantage of the winter sun. Dark-colored metal plates inside the boxes absorb sunlight and change it into heat. (Black absorbs sunlight more than any other color.) Air or water flows through the collector and is warmed by the heat. The warmed-up air or water is then distributed to the rest of the house just like it would be with an ordinary furnace system.



A closed car on a sunny day is like a solar collector. It changes sunlight into heat energy and traps it.

Solar Hot Water Heating

Solar energy can also be used to heat water. Heating water for bathing, dishwashing, and clothes washing is the second biggest home energy cost.

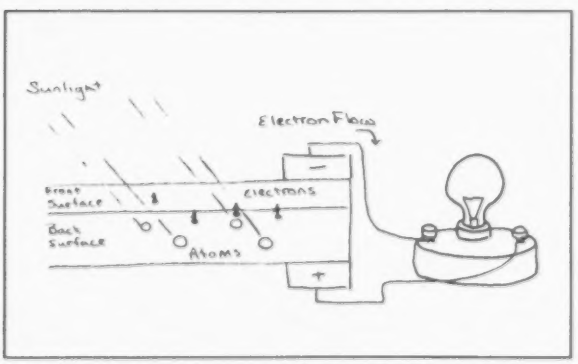
A solar water heater works in pretty much the same way as solar space heating. A solar collector is mounted on the south-side of a roof where it can capture the most sunlight. The sunlight is converted to heat energy which is used to heat water in a tank. Like any ordinary water heater, the hot water is then piped to faucets throughout a house. Today, over 1.5 million homes in the United States use solar water heaters.

Solar Electricity: Photovoltaics and Solar Thermal Power

Besides using solar energy to heat homes or water, solar energy can also be used to produce electricity. Two ways to make electricity from solar energy are photovoltaics and solar thermal power systems.

Photovoltaic Electricity

Photovoltaic comes from the words *photo* meaning "light" and *volt*, a measurement of electricity. Sometimes, photovoltaic is called **PV** for short. You are probably already familiar with photovoltaic cells. Solar-powered calculators, toys, and roadside telephone call boxes all use these solar cells to convert sunlight into electricity.

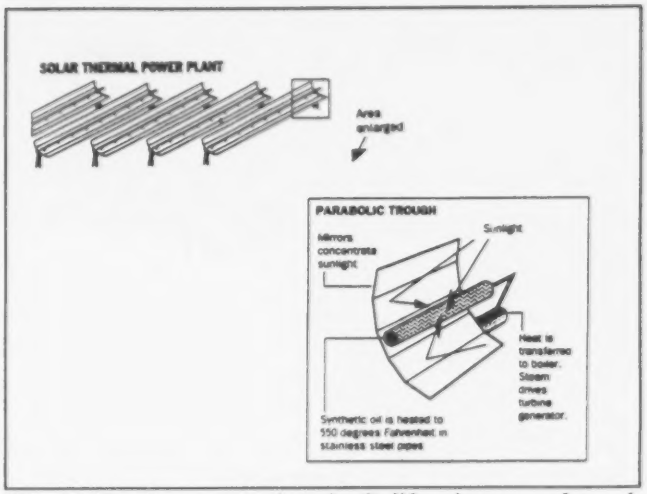


Photovoltaic cells are made up of silicon, the same substance that makes up sand. When sunlight strikes a PV celll, it is changed into electricity.

Photovoltaic cells are made up of **silicon**, the same substance that makes up sand. Silicon is the second most common substance on earth. PV cells can supply energy to anything that is powered by batteries or electrical power. The problem is that this is expensive compared to other ways of producing electricity.

Solar Thermal Power Electricity

Scientists have also developed other ways to produce electricity from the sun. Like PV cells, solar thermal power systems change sunlight into electricity. But they do it in a different way. Solar thermal power systems generally use a solar collector with a mirrored surface to concentrate sunlight onto a receiver which heats a liquid. The super-heated liquid is used to make steam which drives a turbine generator to produce electricity in the same way that coal, oil, or nuclear power plants do.


SOLAR THERMAL POWER PLANT
Area enlarged
PARABOLIC TROUGH
Mirrors concentrate sunlight
Sunlight
Heat is transferred to boiler. Steam drives turbine generator.
Synthetic oil is heated to 550 degrees Fahrenheit in stainless steel pipes

The LUZ solar power plant in California uses solar collectors shaped like water troughs to convert sunlight into electricity.

There are several types of solar thermal power systems, but the most successful is the LUZ power plant in the Mojave desert of California.

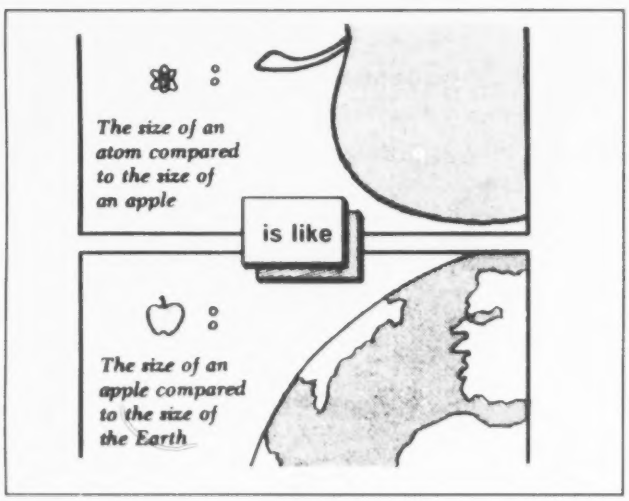
This solar power plant uses mirrored solar collectors shaped like water troughs to collect sunlight. The best news is that the LUZ plant produces electricity as cheaply as most coal or oil-fired power plants.

Solar energy has great potential for the future. The energy is free for the taking and will not run out for billions of years. It does not pollute or otherwise damage the environment. It cannot be controlled by any one nation or industry. Surely, if we can develop the technology to harness the sun's enormous power, we will never again face energy shortages.

Energy Fact Sheet: Uranium/Nuclear Energy

What Is Nuclear Energy?

Nuclear energy is energy that comes from the nucleus (core) of an atom. **Atoms** are tiny particles that make up of every object in the universe. In size, an atom compares to an apple as an apple compares to the earth. Twenty million atoms would cover the head of a straight pin.



Nuclear energy is released from atoms in one of two ways: nuclear fusion or nuclear fission. In **nuclear fusion**, energy is released when atoms are combined or fused together. This is how the sun produces energy. In **nuclear fission**, energy is released when atoms are split apart. Today, nuclear power plants only use nuclear fission to produce electricity.

The fuel most widely used by nuclear plants for nuclear fission is **uranium**. Uranium is a common element found in rocks all over the world. Nuclear plants use uranium as a fuel because its atoms are easily split apart.

During nuclear fission, the uranium atom splits, releasing a great amount of energy in the form of heat, radiation, and some even smaller particles called **neutrons**. A nuclear **chain reaction** begins when one uranium atom splits and neutrons are released. These neutrons crash into other uranium atoms, which split and release more neutrons. The neutrons continue crashing into still more uranium atoms and the cycle repeats itself.

To demonstrate how this works, try to imagine a closed box filled with mousetraps ready to spring. On top of each mousetrap sits a ping-pong ball. If you somehow dropped another ball into the box, what would happen? The first ball would fall onto one mousetrap causing the ping-pong ball to fly upward. That ball would strike another mousetrap causing another ping-pong ball to be "launched" into the air. That ball would strike another mousetrap, launching yet another ping-pong ball, and so on and so on.

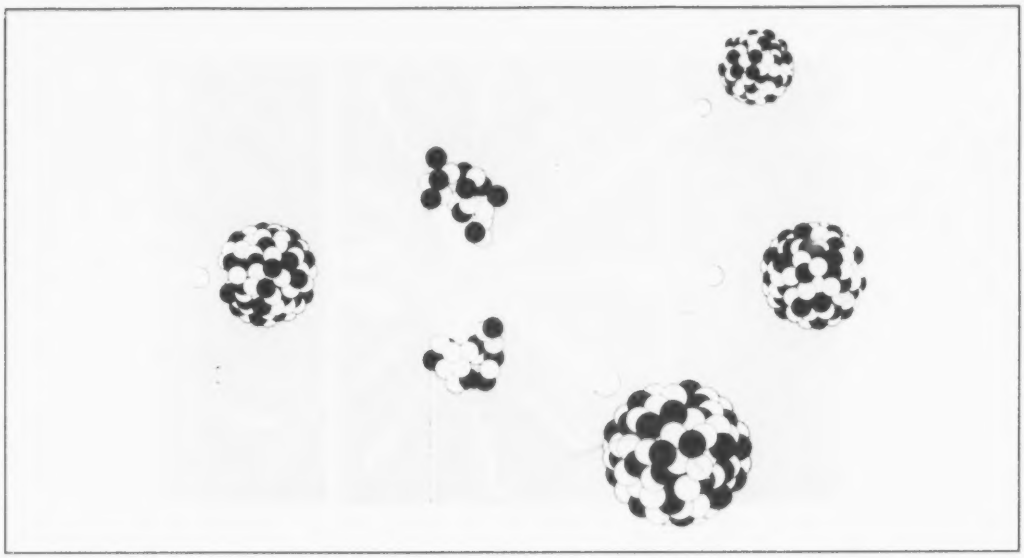
History of Nuclear Energy

Compared to other energy sources, nuclear energy is a very new way to produce energy. It wasn't until the early 1930's that scientists discovered that the nucleus of an atom is made up of particles called protons and neutrons. A few years later, scientists discovered that the nucleus of an atom could be split apart by bombarding it with a neutron – the process we call fission. Soon they realized that enormous amounts of energy could be produced by nuclear fission. Under the dark cloud of World War II, however, nuclear fission was first used to make a bomb. After the war, nuclear fission was used to generate electricity. Today it supplies 19 percent of the electricity used in the United States.

Inside a Nuclear Power Plant

In most power plants, fuel (such as coal or oil) is burned to produce energy. But fuel is not burned in a nuclear power plant. Instead, a nuclear power plant uses the heat energy given off during nuclear fission to produce electricity.

The fission reaction takes place inside the **reactor** of a nuclear power plant. At the center of a nuclear reactor is the **core**. The core of the reactor contains the uranium fuel. The uranium fuel is formed into ceramic pellets. The pellets are about the size of your fingertip, but each one can produce the same amount of energy as one ton of coal or 120 gallons of oil. These energy-rich pellets are stacked end-to-end in 12-foot metal **fuel rods**. A bundle of fuel rods is called a **fuel assembly**.



The Chain Reaction: 1. *A neutron is about to hit the nucleus of a uranium atom.* **2.** *The uranium nucleus splits (fissions) apart, releasing heat, radiation, and several more neutrons.* **3.** *The chain reaction begins; the newly released neutrons hit other nuclei, causing them to fission and so on.* *Illustration Courtesy of USCEA.*

Each fuel assembly is capable of producing an enormous amount of energy. One way to control the heat from nuclear fission is by a second set of rods called **control rods**. These control rods do not contain uranium. When the control rods are lowered into the core, they slow the reaction down. Water flowing around the fuel assemblies also helps to control the reaction.

Nuclear fuel generates heat in a reactor just as coal or oil generate heat in a boiler. The heat is used to boil water into steam. The steam is then blasted against huge turbine blades. As they turn, they drive generators which make electricity. Afterwards, the steam is changed back into water and cooled in a separate structure at the nuclear power plant called a **cooling tower**. In this way, the water can be used again and again.

Nuclear Waste

Nuclear power plants do not produce as much waste as power plants which burn fossil fuels. However, the problem is that some nuclear wastes are radioactive. During the fission process, harmful rays called **radiation** are released. Radiation cannot be seen or touched, but exposure to too much radiation is very dangerous. Material which gives off radiation is called "radioactive." High levels of radiation are harmful to the body's cells and can cause serious diseases such as cancer.

Fuel that has been removed from the nuclear reactor is called **spent fuel**. This used fuel is highly radioactive. The spent fuel is stored near the reactor in a deep pool of water called the **spent fuel pool**.

During storage, the spent fuel cools down and begins to lose most of its radioactivity through a natural process called **radioactive decay**. In three months, the spent fuel will have lost 50 percent of its radiation, in one year it will have lost about 80 percent, and in ten years it will have lost 90 percent. Nevertheless, because some radioactivity remains for as long as 1,000 years, the waste must still be carefully and permanently isolated from the environment.

In 1982, the U.S. Congress passed the Nuclear Waste Policy Act. This law set up a schedule for building America's first permanent high-level nuclear waste storage facility, called a **repository**.

In 1987, Congress chose Yucca Mountain, Nevada as the location for the first repository. If the location is approved, nuclear waste will be sealed in steel canisters and stored in the underground repository drilled into the stable rock formations of Yucca Mountain. Many people who live in Nevada do not want the repository in their state because of possible safety hazards. Others feel that the repository is safe and will bring new jobs to the area.

The NEEd Project wishes to thank the U.S. Council for Energy Awareness for its assistance in producing this fact sheet.

Printed on recycled paper

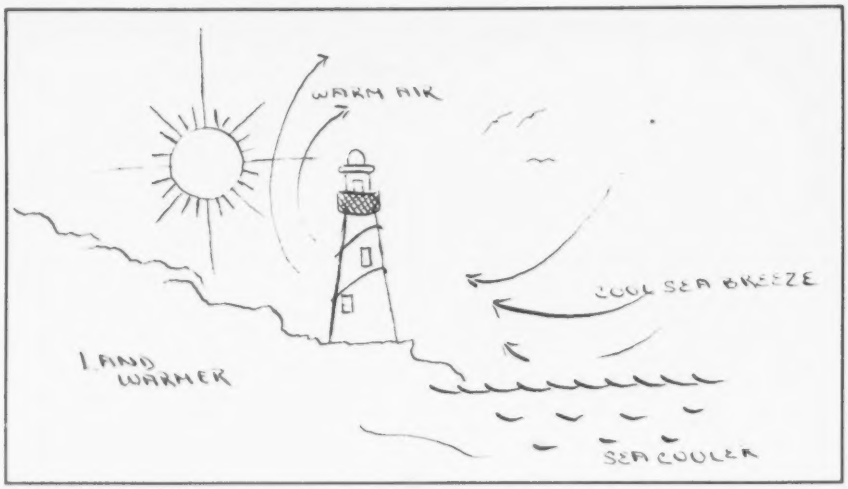
Energy Fact Sheet: Wind

What Is Wind?

Wind is simply air in motion. It is caused by the uneven heating of the earth by the sun. During the day, for example, air above the land heats up more quickly than air above water. The warm air over the land expands and rises, and the heavier, cooler air rushes in to take its place, creating winds. At night, this process is reversed.

Similarly, the large atmospheric winds that circle the earth are created because the land near the earth's equator is heated more by the sun than land near the North and South Poles.

Like solar energy, wind energy is called a **renewable** source of energy because it's something we will never run out of.



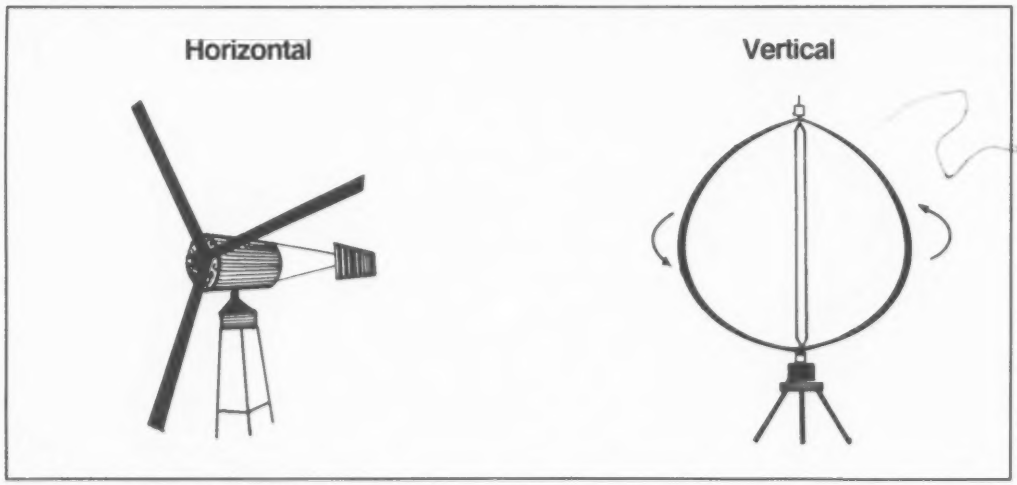
Ocean breezes are created by the uneven heating of land and sea.

The History of Wind Machines

Since ancient times, man has harnessed the wind for his needs. In ancient times, people used the wind to sail ships. Windmills have been used to grind wheat and other grains for hundreds of years. They were widely used in Europe and were brought to this country by early colonists.

American farmers and ranchers used windmills to pump water for irrigating fields and watering livestock. In many places around the world, windmills are still used for these purposes.

Recently, however, people have begun to use wind energy to produce electricity. Wind machines are not practical for every location, but they are beginning to make an important contribution to America's electricity production.



Two types of wind machines are used to produce electricity today.

Today's Wind Machines

Yesterday's windmill is today's **wind machine** or **wind turbine**. Today's machines don't even look a whole lot like yesterday's windmill.

Today two types of wind machines are used: **vertical-axis machines**, which resemble large egg-beaters,

and **horizontal-axis machines**, whose blades resemble airplane propellers.

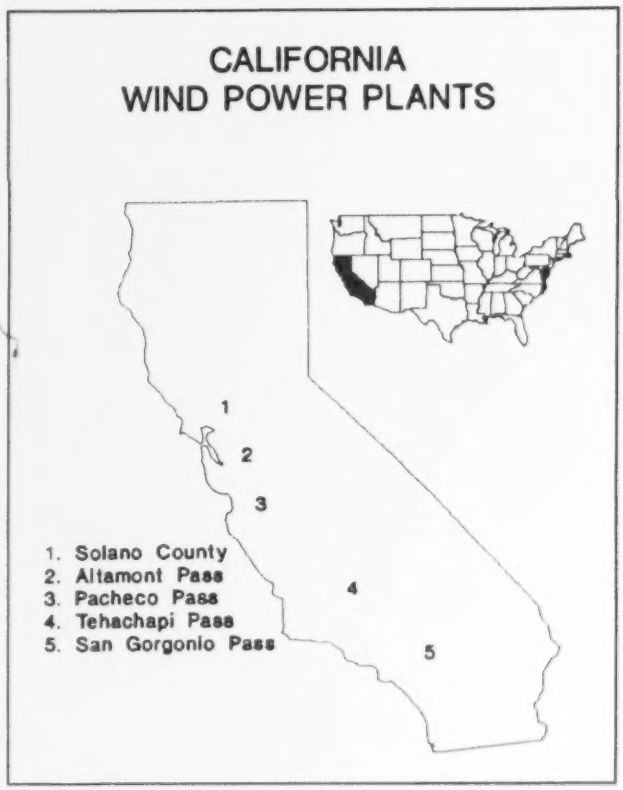
There are good and bad things about each type of machine. For intance, vertical-axis machines can accept wind from any direction and do not require high towers. Horizontal-axis machines, on the other hand, require a "tail" at the back of the machine to keep the blades facing into the wind, and huge towers which make them more difficult to repair than vertical-axis machines. Even so, 95 percent of the wind machines in use today are horizontal-axis machines. Why? Because the horizontal machines can produce more electricity than the vertical machines.

To generate electricity, today's machine still uses blades to collect the wind's energy. But from there, the blades are connected to a drive shaft that turns an electric generator. A magnet attached to the generator moves across a wire, producing an electric current. This electricity is sold to an electric utility which brings the electricity to our homes, schools, offices, and factories.

Wind Power Plants

In order for the wind to generate enough electricity to be sold to a utility company, many wind machines must be installed at a particular site. These **wind farms** or **wind power plants**, as they are called, take advantage of favorable wind speeds to produce large amounts of electricity. In recent years thousands of wind machines have been installed at several locations in the United States.

A modern wind machine produces 250 to 500 thousand kilowatt hours (kwh) of electricity a year. Since an average home consumes, or uses, 7,500 kwh yearly, one wind machine can provide enough electricity for an average of 50 homes per year. Last year, all the wind machines in the United States produced enough electricity to serve the people in a city the size of San Francisco or Washington, D.C.



California has more wind power plants than any place else in the world. Illustration courtesy AWEA.

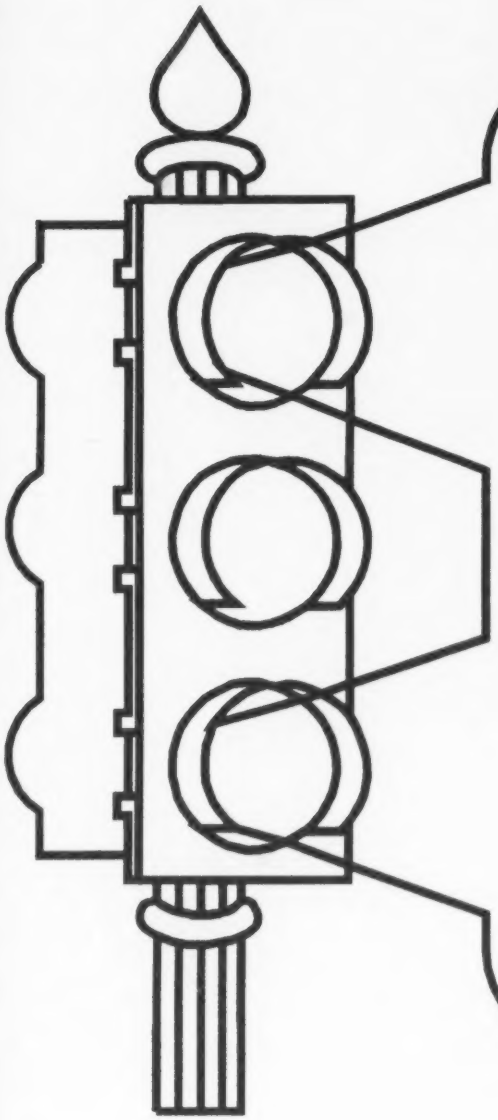
But so far, wind energy is not widely used to produce electricity. For one thing, wind power plants have to be located where the wind blows a lot. If the winds were to blow at a constant speed, wind machines would have a capacity rating of 90 to 95 percent, but because winds don't always blow, the machines have a rating of only 25 percent. That means the machines only run 25 percent of the time.

Wind machines have some advantages though. First, wind machines do not cause any pollution. And, second, unlike coal or petroleum, wind is something that we'll never run out of.

Where Are Wind Machines Used?

In the United States there are many places where wind machines could be used to make electricity. Alaska, Hawaii, the Great Plains, and several mountainous regions all have enough wind to produce electricity. But today almost all wind machines are located in California. In fact, California is home to over 80 percent of the wind machines in the world. Holland, Denmark, Australia, Germany, and Japan are other nations which have looked to the wind as an alternative energy source.

The NEED Project wishes to thank the American Wind Energy Association for its assistance in producing this fact sheet..



STOP! Do Not Turn To The Next Page...

...Unless You Want To Learn How To Use The NEED Local Participation Kit!

Teacher's Instructions to NEED Activities

Important!

Please read this section first! It contains information which will give you a clearer picture of what NEED is committed to educationally, and instructions on how to implement the many suggested activities into your energy unit or program.

NEED is more than just an energy program. It's a philosophy of education.

We are proud of the fact that the NEED Project is concerned with more than just the dissemination of energy education information. It is also very concerned with the way children learn best and the type of informed citizen they will become in tomorrow's very complex society. A dominant arm of this effort, therefore, is COOPERATION. The basic elements of the cooperative arm structure are positive interdependence, individual accountability, face-to-face interaction, and cooperative skills. Once involved, students will seek outcomes that are beneficial to the majority. They must discuss the material with each other, help one another understand it, and encourage each other to work hard to reach their goal(s).

This group learning approach to energy education has proven to be very effective. Students take responsibility for their own learning and that of others in their group, class, school, and even their community. They are given many opportunities to develop leadership skills, and to strengthen their research and group dynamics skills. The development of these skills, by the way, is often never pursued in a traditional classroom setting.

NEED activities like Great Energy Rock Performances or the Senate Energy Hearings, may start off as a sheet of paper handed out by a teacher, but they can soon become exciting and enjoyable projects as students bring them to life.

This ownership component of NEED is what truly makes the project an effective instructional method. Teaching oneself and others about a topic is what makes the student absorb more cognitive information and retain it for a longer time. It also promotes feelings of accomplishment, pride, and cameraderie among students.

Using NEED Activities

Some NEED activities, such as Energy Bingo or Energy Roundup are group ice-breakers or energizers. They are intended to get students to begin working cooperatively. Other activities such as Energize Your Local D.J. and Energy Placemats are loosely structured, although they still draw upon many of the same skills as the more structured cooperative learning activity units.

You may decide to have each student group in your class work on the same activity, such as the Energy Museum or Great Energy Rock Performances. Or you may decide to assign each group a different activity, placing those students in an activity which meets their talents and strengths. For example, strong writers might develop a newspaper using the Energy Times activity, while another group of students interested in politics might be given the Senate Energy Hearings activity unit. Still another group of students interested in teaching as a profession might develop a lesson on energy using the Adopt A Class activity.

Printed on recycled paper

Another possibility is to assign each group a scene from the NEED '91 play, *The Incredible Energy Tales* in addition to an independent activity. Therefore students would be responsible for one scene of the play as well as for an exhibit in the Energy Museum. Similarly, Great Energy Rock Performances could be assigned to student groups in addition to another assigned activity.

Additional Research Information

The NEED Resource Guide isn't the only place your students will find information on energy topics. Many of the activities also contain valuable facts – for example, the Energy Group activity includes information on petroleum production and consumption in the 1990s. The "Let's Talk Energy Show" activity includes information on mileage ratings for new automobiles. Remind your students to review these activities and others as they do their research. NEED will continue to supply you with materials throughout the remainder of the school year. You will receive three issues of *The Energy Exchange* magazine along with other materials as they are developed.

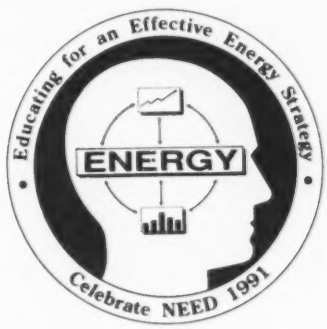
Wanted: Ideas for Future NEED Activities

The NEED Project is always looking for new ideas that it can share with other educators. Many of the activities in this packet are a result of the ideas that have been passed along. If you have created an activity that you think has merit send it along to us. If accepted, we'll work with you to refine the activity and will include it in our future activity packets. You and your school will be acknowledged in the activity unit.

Wanted: NEED Network Leaders

Through the sharing of activities, materials, and program successes, NEED gets its strength from its thousands of network members. The network needs leaders to conduct its state and regional programs, and welcomes its members to take an active role in building and directing the network. If you are interested in getting involved in the network contact your state coordinator. Your coordinator is extremely knowledgeable and is willing and able to answer your questions. Your coordinator can give you information about newsletters, workshops, publications, awards programs, and energy events. You can benefit from your coordinator's experience when you want to get a NEED program started in your school. Also, be sure to ask your coordinator about getting involved in your state or regional NEED committee.

If you are unable to locate the name, address, or phone number of your state coordinator, contact NEED Headquarters at (703) 860-5029.



Group Contract

Directions: One member of your group should read the section below aloud as the other members of the group follow along.

Team Spirit

When a football team wins a championship, or a producer's movie wins an award, or a medical team makes a great scientific discovery, the spokesperson for the group thanks all the people involved in the effort.

In the case of a winning Super Bowl team, the coach gives credit for the victory to his assistant coaches, the football players, the scouts, the owner, and the fans. At the Academy Awards, the producer of the best picture thanks the writers, the actors, the cinematographers, and the many others who made the film a success. And when you hear about a medical team that's developed a new artificial limb or organ, or found the cure for a disease, credit goes to the doctors, the biologists, the technicians, and the support staff.

In all these cases, a group of people, each with different skills and abilities, worked together for a common goal. When they achieved their goal, the members of these groups felt proud to be a team member. Most leading actors and star athletes will tell you that the team spirit and accomplishments were sweeter to them than the individual praise they received for their performances.

Your Contract

The purpose of this Group Contract is to have the members of your group discuss the importance of team work, and to make a commitment to do their best on your energy project. A weak member of the group can cancel out the outstanding efforts of the others.

Take five minutes to discuss unsuccessful group experiences that members of your group may have had as a member of a softball team, a Girl Scout troop, a band, or the like. What did it feel like to be part of an unsuccessful team? What made the team unsuccessful? Develop an 8 to 10 item list and be ready to hand it in to your teacher at the end of this assignment.

Take another five minutes to discuss successful group experiences that members of your group may have had. What did it feel like to be part of a winning team? What made the team so successful? Develop an 8 to 10 item list and be ready to hand it in to your teacher at the end of this assignment.

Your group should now discuss what each member of your group must do to make your energy education project one of the best ever created by a group of students. As you set your goals, keep in mind that, in many cases, your project can be submitted for state and national awards. Now write a contract that all the members of your group can agree on. A typical group contract might be written as shown below.

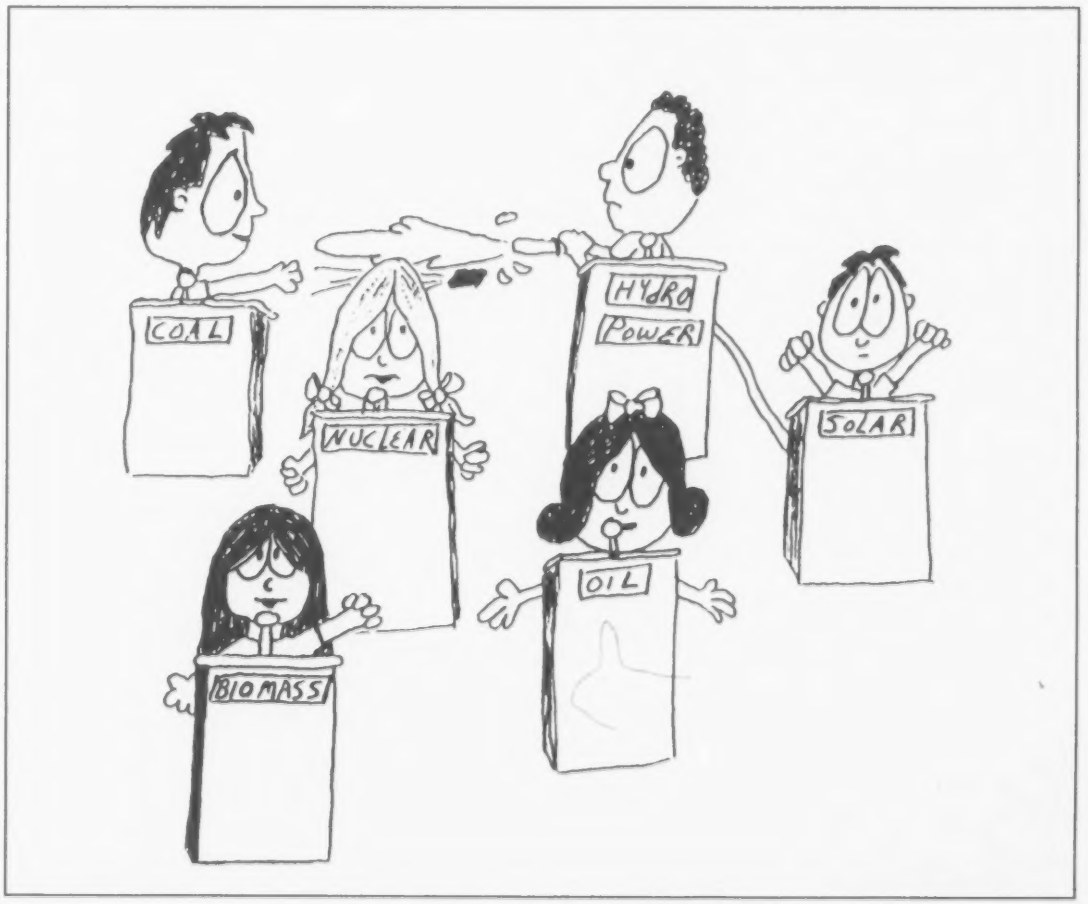
We, the members of the (name of project) agree to:

- *get our work in on time;*
- *give 100 percent effort;*
- *rehearse parts at home;*
- *give the proper amount of time to a task;*
- *not be a disruptive force during group meetings and work time;*
- *give criticism in a positive way.*

Once your group has written its contract, all the members must sign it. Then give the completed contract to your teacher along with your group's two lists.

National Energy Education Development Project

The Great Energy Debate Game



The Great Energy Debate Game

(Teacher's Guide)

Objectives: Students will be able to research and identify advantages and disadvantages, specifically environmental, of the major sources of energy.

Materials:

1. One *Great Energy Debate Game* Student Sheet per student.
2. One Energy Source Fact Sheet per student for the team's assigned source.
3. A set of Energy Source Fact Sheets for each group.
4. A set of YES/NO cards for the judges.
5. A transparency of the *Great Energy Debate Game* Board.

Time: 60 minutes

Directions:

1. Students will work in assigned groups as a team.
2. The teacher should go over the *Great Energy Debate Game* Student Sheet with the students as they follow along on their own copy.
3. A panel of judges is to be selected. Either the teacher can be the judge, or each group can select one person from their team to serve as a judge. Each judge is given a YES/NO card.
4. For the next five minutes, each Debate Team should work on the advantages, disadvantages and irrelevant facts of their assigned source.
5. During the second half of research time, the Debate Team should divide into small sub-groups with no more than two people in a group. This sub-group is assigned one or two of the opposing energy sources, and it is the sub-group's responsibility to find the disadvantages of those energy sources. The number of students participating in the game determines the amount of time given to this step. Usually, ten minutes is sufficient.
6. Playing The Game – The first team is given the opportunity to move their token up by giving an advantage of their energy source. Action continues until a team reaches the winners line (top line), until time is called by the teacher, or until the players have gone through the number of rounds chosen for the game.
7. At the conclusion of the game, discussion should point out that all sources of energy have advantages and disadvantages. Some of the disadvantages affect the environment.
8. Interpret the game results:
   - Why isn't there an obvious winner in this game?
   - Even if the game could continue, would there be a winner? Why or why not?
   - Do these sources have negative effects on our environment? What?
   - Why do we still use them?
   - What are some other factors that we need to consider in our choice of energy sources?

This activity was developed by Rich Ammentorp, Elementary School District 54, Schaumburg, Illinois

Printed on recycled paper

The Great Energy Debate Game

(Student Sheet)

You will be divided into six teams. Each team will represent one of the six main sources of America's energy: petroleum, coal, natural gas, nuclear, hydropower and biomass. Your teacher will assign one of these sources to your team.

The attached "Energy Source Fact Sheets" contain data and information that was collected in 1989. Some of the information may be IRRELEVANT. That is, the facts are true, but they do not defend your energy source, nor are they disadvantages about your energy source. Other facts may be ADVANTAGES about your energy source. These will help your team advance forward in the game. You will also need to look for the DISADVANTAGES of your energy source because these disadvantages may allow your opponents to move you backwards.

1. You will be given five minutes to fill out your team's Energy Source Fact Sheet. As a group, your team will need to decide if each statement is an advantage, a disadvantage or an irrelevant fact.

2. You will be given time to fill out the Energy Source Fact Sheets for the other five sources. Once again, decide which statements are advantages, disadvantages or irrelevant facts. In order to complete all the the fact sheets, you will need to sub-divide into smaller groups.

3. START OF GAME – The first team will be given the opportunity to move their token up by giving an advantage of their energy source. They may choose instead to move an opponent's token down by giving a disadvantage to the opponent's energy source. Several teams may be working to prevent one team from winning. It should be noted that if any one team makes it to the top, the game is automatically over and the remaining four teams are all losers and go to the bottom of the game board.

4. Each team will present their advantages or disadvanges to a panel of judges. If the first team gives an advantage of their energy source and the judges agree with them, then the team moves up one space. An opposing team can object to the judges' decision. The opposing team will first try to convince the judges why the statement is not an advantage. The first team will then have the opportunity to defend its decision. The judges will vote again and one of two things may happen. The judges may vote in favor of the first team and they move up one space – the opposing team loses its turn. The judges may decide the statement is a disadvantage or irrelevant and the first team moves down.

5. If a team states a disadvantage to try to move an opposing team down, then the opposing team can defend themselves without penalty.

Example:

	Relevant		
	Irrelevant	Advantage	Disadvantage
1. The sun's energy is renewable.		X	
2. The sun is 93 million miles from the earth.	X		
3. The sun does not always shine.			X

1. *The fact that the sun's energy is renewable is considered an advantage.*
2. *The sun's distance from the earth is a fact that is neither an advantage or a disadvantage – it is just unnecessary information.*
3. *One of the disadvantages of the sun as an energy source is the fact that the sun doesn't always shine.*

The Great Energy Debate Game

NATURAL GAS	COAL	OIL	NUCLEAR	HYDRO POWER	BIOMASS

ADVANTAGES

START HERE

DISADVANTAGES

Energy Debate Game
Energy Source Fact Sheet

OIL

	Relevant		
	Irrelevant	Advantage	Disadvantage
1. The word "petroleum" is derived from the word "petro" meaning rock, and the word "oleum" meaning oil.			
2. Petroleum is believed to have formed over a period of years from the decomposition of buried marine plants and animals.			
3. Crude oil is petroleum before it is refined. Crude oil is what comes directly from the oil well.			
4. Oil deposits are found in many areas, especially along the ocean coasts.			
5. Locating oil deposits is not as simple as finding coal.			
6. Petroleum in the form of crude oil is not directly usable. Petroleum must be refined.			
7. Building oil refineries is expensive and takes several years.			
8. It is sometimes difficult to find a place to build a refinery. (Who wants a refinery in their backyard?)			
9. Petroleum is a complex mixture of hydrogen and carbon.			
10. "Cooking" petroleum at different temperatures makes the hydrogen and carbon atoms combine in many different ways.			
11. We can get many products from "cooking" petroleum at different temperatures, such as gasoline, kerosene and oil. These can be burned to heat, light and generate electricity or produce motion.			
12. We also get chemical products from petroleum and from these we can make plastics, medicines and fertilizer.			
13. When oil is burned in an electric power plant, smoke and other residues are released to the atmosphere.			
14. Oil must be transported by pipeline, truck or tanker to the places where it is refined and/or used.			
15. Sometimes oil is spilled into the oceans or other bodies of water when something goes wrong at the drilling site or when oil tankers wreck.			
16. Oil production in U.S. oil fields has been declining at the rate of about 10% per year since 1970.			
17. We do not yet have the methods to recover much of the oil that is under our lands and waters.			
18. The United States imports about 46% of its petroleum from other countries.			
19.			
20.			

Energy Debate Game
Energy Source Fact Sheet

COAL

	Relevant		
	Irrelevant	Advantage	Disadvantage
1. Coal is the most abundant fuel in the United States. We have a 300 year supply at the current rate of consumption.			
2. Although coal is still being formed today, we use it thousands of times faster than it is formed.			
3. Coal, oil, and natural gas are all the result of the decomposition of living matter (plants and animals).			
4. Nearly 60% of the world's coal reserves are found in the Soviet Union.			
5. Coal has been burned to heat food, air and water for thousands of years.			
6. Today, most coal is used to heat water to make electricity.			
7. When coal is burned, smoke, ash and other residue are released into the atmosphere.			
8. To remove coal from the earth, mine shafts are constructed in order to bring the coal up from beneath the surface.			
9. An easier way to mine coal is to strip away layers of earth to uncover the coal.			
10. Huge amounts of land are torn up in the process of surface mining.			
11. Some surface mines are now being restored to grasslands and parks. We are still learning how to do this successfully.			
12. Where surface mines are left open, they are usually considered unusable areas. The land around these mines suffers from landslides, erosion and sedimentation.			
13. Sometimes the water that has filtered through abandoned surface mines picks up chemicals that pollute the water.			
14. Coal can also be turned into other materials or products we can use.			
15. Coal can be turned into gas. This process is still too expensive to be used to replace oil and natural gas.			
16. Many coal miners have suffered from lung diseases because they breathe in so much coal dust when they work in the mine.			
17. New technologies allow coal to be burned in a cleaner way.			
18. Clean burning coal technologies require less coal to produce the same amount of electricity.			
19.			
20.			

Energy Debate Game
Energy Source Fact Sheet

NATURAL GAS

	Relevant		
	Irrelevant	Advantage	Disadvantage
1. Coal, oil, and natural gas are all the results of the decomposition of living matter.			
2. Coal, oil, and natural gas are commonly referred to as "fossil fuels."			
3. Natural gas can be burned as it is found without refining.			
4. Natural gas can be refined and other products taken from it. (This is similar to milk being refined to make butter.)			
5. Natural gas is the cleanest burning of the fossil fuels.			
6. Generally, natural gas and crude oil are found together in underground deposits.			
7. In the past, oil drillers were not interested in the natural gas that was found at the site of the oil well. Often the gas that came up with the oil was burned off at the site – wasted.			
8. The invention of high-pressure pipe has made it possible to ship gas all over the U.S.			
9. Sometimes leaks occur in this pipeline. Fires and explosions can result from these leaks.			
10. The U.S. imports 5% of the natural gas it uses.			
11. Natural gas is considered a non-renewable resource.			
12. Each process we put a fuel through to make it cleaner or to extract products from it affects the cost of that resource.			
13. Natural gas was once considered a "cheap fuel."			
14. Today, natural gas costs the consumer about the same as oil.			
15. When supplies of a resource are limited, we make decisions how to best use the limited resource. These decisions are made based on our present and future needs.			
16. Natural gas can be used as a clean transportation fuel.			
17. At today's prices, natural gas supplies will last about 50 years.			
18. At higher prices, natural gas supplies could last over 200 years.			
19.			
20.			

Energy Debate Game
Energy Source Fact Sheet

NUCLEAR

		Relevant	
	Irrelevant	Advantage	Disadvantage
1. 109 nuclear power plants are licensed to operate in the U.S. today.			
2. These plants provided about 20% of the electricity generated in the U.S. last year (1989) or about 7.1% of our total energy consumption.			
3. A nuclear reactor can supply a large amount of energy using a small amount of fuel.			
4. The construction of nuclear power plants is expensive compared to coal or oil fired plants.			
5. Nuclear reactors generate electrical power without giving off smoke and fumes.			
6. The fuel used in nuclear power plants is called uranium and is easy to transport.			
7. Mining uranium causes less disruption to the countryside than the mining of fossil fuels, particularly coal.			
8. People who work in uranium mines have a higher risk of radiation-induced cancer diseases than the "average" person.			
9. During normal operation, every nuclear reactor releases small amounts of radioactivity into the atmosphere.			
10. At present, persons living near nuclear power plants (in normal operation) receive less radiation from the plant than they do from other sources like medical x-rays and color TV sets.			
11. Parts of nuclear reactors become radioactive after they have been used.			
12. The current plan is to start storing nuclear waste in Yucca Mountain, Nevada, by 2003.			
13. Presently, there are about 200 million gallons of radioactive waste from nuclear power plants being stored underground in huge concrete tanks.			
14. Uranium is a non-renewable resource.			
15. Nuclear power plants will exhaust about 1.5 times as much heat to the environment as will a coal burning plant. If this heat is exhausted into a moving water system, there will be an increase in the water temperature.			
16. In 1939, scientists discovered that certain atoms could be split – releasing a great deal of energy.			
17. The main potential health hazard from a nuclear power plant is radiation exposure.			
18. Nuclear reactions can be controlled so that they do not explode but instead produce a steady amount of heat. This heat is used to generate electricity.			
19.			
20.			

Energy Debate Game
Energy Source Fact Sheet

BIOMASS

	Relevant		
	Irrelevant	Advantage	Disadvantage
1. Biomass is a source of fuel made from plant materials and animal waste.			
2. Biomass is a renewable energy source; we won't run out of it.			
3. Biomass is perishable making it difficult to store and transport.			
4. Biomass is one of the oldest sources of energy known.			
5. Biomass can be found throughout the nation.			
6. The energy stored in biomass is much less than the energy stored in an equal amount of fossil fuel.			
7. Biomass can be used as a fuel because it captures and stores energy from the sun by a process called photosynthesis.			
8. Biomass is abundant.			
9. The burning of biomass can have a harmful effect on the environment.			
10. Burning garbage in a trash-to-energy plant reduces the volume of trash by 90%.			
11. Biomass provides approximately 3.5% of the nation's energy needs.			
12. Almost 90% of biomass energy is provided by wood, and two-thirds of this wood is consumed by industry.			
13. Scientists are working on trees that can reach full size in less than half the time.			
14. Cutting down trees for energy would increase the amount of carbon monoxide in the air.			
15. Biomass (corn) can be made into a transportation fuel which is cleaner-burning than unleaded gasoline, with one-third less carbon monoxide in the exhaust.			
16. Alcohol fuels made from biomass are currently more expensive than conventional energy sources.			
17.			
18.			
19.			
20.			

92

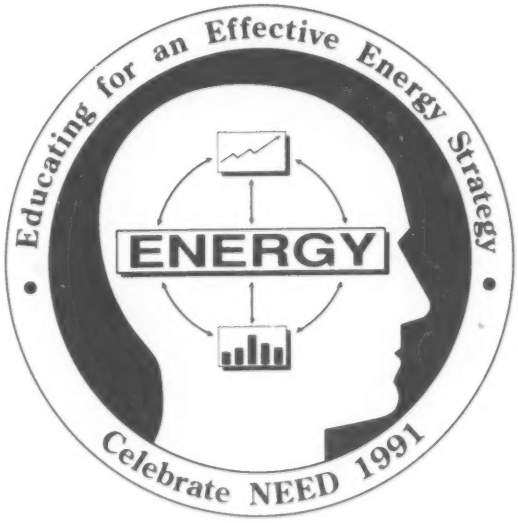
Energy Debate Game
Energy Source Fact Sheet

HYDROPOWER

		Relevant	
	Irrelevant	Advantage	Disadvantage
1. Moving water has been used as a source of energy for thousands of years.			
2. Today, water power is still considered the cleanest of our energy sources.			
3. Water is considered a renewable resource as long as rain continues to fall.			
4. Moving water can be used to generate electricity. This process takes place in a hydroelectric power plant.			
5. Water power was probably first used to turn wheels to grind grain.			
6. Hydroelectric power is considered reliable because dams can be built to store water. Controlling the flow of this stored water allows the plant to operate regardless of weather conditions.			
7. In 1989, 9% of the total U.S. electricity was generated by hydroelectric plants.			
8. In 1989, hydropower provided the U.S. with 3.5% of our total energy consumption.			
9. Thirty years ago, hydroelectric plants supplied 40% of the total U.S. electricity.			
10. The nation's largest producer of hydroelectric power is the federal government.			
11. There are about 2,000 hydroelectric power dams in the U.S. today.			
12. There are about 47,000 dams that *do not* have generating plants on them.			
13. If we built generating stations at the most suitable dams and built new dams on suitable rivers we could perhaps double our hydroelectric capacity, saving more than four million barrels of oil per day.			
14. When a dam is built, thousands of acres of land are flooded to create a reservoir.			
15. Flooding destroys and alters the plant and animal habitats of that area.			
16. Reservoirs are often used for recreation such as boating, hunting and fishing.			
17. The U.S. Bureau of Reclamation is studying the idea of combining wind and water power at hydroplants along the Colorado River. Wind power would be used during the winter when water flow in the river decreases. Water power would be used in the summer when winds are less reliable. Using the two systems at one plant improves reservoir flexibility.			
18. Some countries use more hydroelectric power than the U.S. Brazil gets more than 80% of its electric energy from hydroelectric sources. Japan gets about 40%.			
19.			
20.			

The NEED Energy Education Poll, a great activity for 1991

1991 NEED Energy Education Poll



How much do students and adults really know about energy?

How do they feel about certain energy issues?

Use NEED's 1990 Energy Education Poll to find out.

Conducting a pre-NEED and/or post-NEED Energy Education Poll might seem like a major job, especially if statistics scare you off. However, having your school participate in this nationwide poll will actually be quite easy.

The first thing your school needs to do is request the appropriate number of NEED Energy Education Poll scanning cards (middle, secondary or both) for those who will be taking the poll. Grade levels indicated on the order form are suggested, not required. Decide if you want to administer the poll to all students, or to just a select group of students, i.e., full-year science students or a random sample of the student body. Also, decide if you want to poll teachers and adults in your school community. Once you've come up with a number, fill out the form below and mail it to NEED. The minimum order is 50 scanning cards. After the initial order of 50 cards, you can only order in increments of 25. Along with your scanning cards, we'll send you information with helpful hints on how to best administer the poll. **You will also receive a class set of 30 polls.**

Once you have administered the poll, just mail back the completed scanning cards to the NEED Project Data Processing Center, and we will take it from there. In about ten days, you will receive your poll results along with 30 graphs telling you exactly how your group did. Now doesn't that sound easy?

NOTE:

If you are a NEED member from the following states, your poll cards and processing of the cards are free.

Alabama	Missouri
California	New Hampshire
District of Columbia	New York
Delaware	Ohio
Illinois	Oregon
Indiana	Rhode Island
Massachusets	Tennessee
Michigan	Virginia
Minnesota	West Virginia

ALL OTHER STATES: Please contact your State Coordinator or NEED Headquarters (703) 860-5029 to receive more information on the availability of cards and data processing.

Printed on recycled paper

Order Form

NEED Energy Education Poll Scanning Cards

Please Print:

_____

Name

_____

School

_____

Street Address

_____

City State Zip Code

_____

Area Code/Telephone Number Best hours to reach me

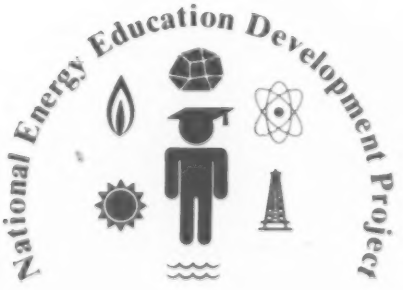
Please send me:

_____(#) cards for the **middle** polls (grades four through nine, adults and educators).

_____(#) cards for the **secondary** poll (grades eight through twelve, adults and educators).

Mail completed form to:

NEED Poll Cards
NEED Project Data Processing Center
P.O. Box 2012
West Lafayette, IN 47906



(Form S)

NEED Energy Education Poll

This Is Not A Test
This is not a test so don't worry! We are only interested in finding out how much you know or what your opinion is about an energy subject. Just relax and don't make any wild and crazy guesses. Read the sentence and choose the response that most closely matches your ideas or feelings. Choose "I Don't Know" if you have absolutely no idea and cannot even make a good guess. Choose "Undecided" on the opinion questions if you have never thought about the issue, or if you have not made your mind up yet. Be sure to use a No. 2 pencil, and completely fill in the circle on the Poll Response Card that best completes the sentence or best answers the question for you.

---

1. How informed are you about energy and energy issues?

   A. Very informed
   B. Informed
   C. Somewhat informed
   D. Slightly informed
   E. Uninformed

2. How interested are you in learning more about energy?

   A. Very interested
   B. Interested
   C. Somewhat interested
   D. Not interested at all
   E. Undecided

Conservation

3. Which of the following statements best describes your energy consuming habits?

   A. I don't think about saving energy.
   B. I don't care about trying to save energy.
   C. I sometimes remember to save energy.
   D. Most of the time I try to save energy.
   E. I always try to save energy whenever I can.

4. Which energy job consumes the greatest amount of energy in the American home during a year?

   A. Lighting
   B. Refrigeration
   C. Heating and cooling rooms
   D. Heating water
   E I DON'T KNOW

5. In 1973, the average new automobile made in the U.S. got 13 miles per gallon (mpg). During the past 16 years mpg ratings for new domestic cars have increased to 27 mpg. Which factor listed below was MOST responsible for this increase in mileage?

   A. Radial tires
   B. Lighter cars
   C. More technologically advanced engines
   D. Sleeker car body designs
   E. I DON'T KNOW

6. Presently, an automobile manufacturer's fleet of cars must average 27.5 miles per gallon. Laws are being suggested in the U.S. Congress to raise this number to 33 mpg by 1995, and 40 mpg by the year 2000. Doing this will reduce our consumption of petroleum, but Americans may have to drive smaller cars with fewer options which are built for economy rather than for performance. Which of the following phrases best describes your opinion on the following statement?

   The consumer should be given the choice of purchasing the size and performance level of their car and not be limited by higher federal mileage standards.

   A. Strongly Agree
   B. Agree
   C. Disagree
   D. Strongly Disagree
   E. Undecided

87

- OVER -

7. Recycling saves energy and natural resources. In some communities laws require people to sort their trash, separating the glass, metals, plastics and paper. Which of the following statements best describes your feelings on how the level of recycling can be increased?

A. Laws should be made requiring people to recycle.
B. Advertising and informational programs, and not laws, should be developed to encourage people to recycle.
C. Trash should be sorted at a separation plant, not at home, and people should pay a fee for this service.
D. A deposit should be placed on all recyclable materials which people could get back when they return the items to a recycling center.
E. Undecided

Renewable Energy

8. Solar, biomass, geothermal, wind and hydropower energy are all renewable sources of energy. They are CLASSIFIED as renewable sources of energy because they...

A. are clean and free to use.
B. can be converted directly into heat and electricity.
C. can be replenished by nature in a short period of time.
D. were stored in fossil fuels millions of years ago.
E. I DON'T KNOW

9. In 1990, what percent of the nation's energy was supplied by renewable sources of energy?

A. 1%
B. 10%
C. 25%
D. 40%
E. I DON'T KNOW

Fossil Fuels

10. Petroleum (oil) provides the nation with 41 percent of its total energy demand. What is the major product produced from the refining of petroleum?

A. Heating oil
B. Chemicals for fertilizers
C. Asphalt for roads
D. Gasoline
E. I DON'T KNOW

11. Not enough petroleum (oil) is produced in the U.S. to meet the nation's demand. We must import petroleum from other countries each year to meet our needs. At what level would you feel that imports were starting to approach a dangerously high level, threatening the nation's economic and military security?

A. 10% of demand provided by imports
B. 33% of demand provided by imports
C. 50% of demand provided by imports
D. 67% of demand provided by imports
E. Undecided

12. Some people say that more domestic petroleum must be produced to reduce the nation's level of imports. Petroleum from Alaska and from offshore areas seem to hold the most petroleum reserves. Some feel these areas are too valuable to chance an environmental accident, and that we should drill for petroleum only when it is absolutely necessary. Others feel that it is necessary now. How do you feel about the following statement?

The federal government should allow exploration and development of petroleum resources in Alaska and from offshore areas as soon as possible.

A. Strongly Agree
B. Agree
C. Disagree
D. Strongly Disagree
E. Undecided

13. Many people are suggesting that more natural gas be used in the future instead of coal and petroleum. This is because natural gas is...

A. the nation's most abundant fossil fuel.
B. the cleanest burning fossil fuel.
C. the cheapest source of heat energy.
D. the easiest to transport.
E. I DON'T KNOW

14. The major use of natural gas today is for...

A. the heating of homes and buildings.
B. making plastics.
C. fueling cars and buses.
D. generating electricity.
E. I DON'T KNOW

15. Liquid propane is used instead of natural gas in fueling hot air balloons, recreational vehicles in suburban areas and for many uses on the farm. Why is propane often used instead of natural gas?

A. It's safer
B. It's more portable
C. It's cleaner
D. It's cheaper
E. I DON'T KNOW

16. The major use of coal today in the U.S. is to...

A. generate electricity.
B. fuel trains.
C. make steel.
D. heat buildings and homes.
E. I DON'T KNOW

17. Measures can be taken to reduce the amount of air pollution which is given off from burning fossil fuels. These measures would raise the price of energy and manufactured products. Which of the five phrases best describes your opinion on the following statement?

Measures to lower the level of air pollution produced from burning fossil fuels should be taken, even if the price of energy and manufactured products increases by 10%.

A. Strongly Agree
B. Agree
C. Disagree
D. Strongly Disagree
E. Undecided

Electrical Energy

18. One kilowatthour of electricity will operate a television set for about six hours, or run a hair dryer during normal use for about five days. In 1989, what was the average price for a kilowatthour of electricity?

A. $0.08
B. $0.58
C. $1.08
D. $1.58
E. I DON'T KNOW

19. Which energy source was responsible for generating over half the nation's electricity in 1989?

A. Coal
B. Uranium (nuclear)
C. Hydroelectric power
D. Natural gas
E. I DON'T KNOW

20. If a new electric power plant is needed in your area how would you feel if the plant under consideration was a nuclear power plant? I would...

A. actively work to support its construction.
B. support its construction but remain silent.
C. oppose its construction but not get involved.
D. actively oppose its construction.
E. Need more facts before I could decide.

21. Improved technology within in the next 25 years will enable power plants to be nearly 100% efficient, converting almost all the energy they consume into electricity.

A. Strongly Agree
B. Agree
C. Disagree
D. Strongly Disagree
E. Undecided

(Form M)

NEED Energy Education Poll

This Is Not A Test
This is not a test so don't worry! We are only interested in finding out how much you know or what your opinion is about an energy subject. Just relax and don't make any wild and crazy guesses. Read the sentence and choose the response that most closely matches your ideas or feelings. Choose "I Don't Know" if you have absolutely no idea and cannot even make a good guess. Choose "Undecided" on the opinion questions if you have never thought about the issue, or if you have not made your mind up yet. Be sure to use a No. 2 pencil, and completely fill in the circle on the Poll Response Card that best completes the sentence or best answers the question for you.

---

1. How informed are you about energy and energy issues?

   A. Very informed
   B. Informed
   C. Somewhat informed
   D. Uninformed

2. How interested are you in learning about energy?

   A. Very interested
   B. Interested
   C. Somewhat interested
   D. Not interested at all

Conservation

3. Which of the following statements best describes your energy using habits?

   A. I don't think about saving energy.
   B. I don't care about trying to save energy.
   C. I sometimes remember to save energy.
   D. I always try to save energy whenever I can.

4. Which of the following uses the greatest amount of energy in the American home during a year?

   A. Lighting
   B. Heating hot water
   C. Heating and cooling rooms
   D. I DON'T KNOW

5. Should people be required by law to save energy in their cars and homes?

   A. Definitely no
   B. Only in an energy emergency
   C. Yes, because people won't do it on their own
   D. I'm not sure

6. Recycling does saves energy and natural resources. Some communities even have recycling laws that require people to sort their trash, separating the glass, metals, plastics and paper. Which of the following statements best describes your feelings on how the level of recycling can be increased?

   A. Laws should be made requiring people to recycle.
   B. Advertising and informational programs, and not laws, should be developed to encourage people to recycle.
   C. Trash should be sorted at a separation plant, not at home, and people should pay a fee for this service.
   D. Undecided.

Renewable Energy

7. Solar, biomass, geothermal, wind, and hydropower energy are all renewable sources of energy. They are CLASSIFIED as renewable sources of energy because they...

   A. are clean and free to use.
   B. can be converted directly into heat and electricity.
   C. can be replenished by nature in a short period of time.
   D. I DON'T KNOW

100

- OVER -

8. In 1990, what percent of the nation's energy was supplied by renewable sources of energy?

A. 1%
B. 10%
C. 25%
D. I DON'T KNOW

Fossil Fuels

9. Coal, petroleum (oil), natural gas, and propane are fossil fuels. They are CLASSIFIED as fossil fuels because:

A. we burn them to release energy.
B. they are formed from the buried remains of plants and animals that lived millions of years ago.
C. they are non-renewable.
D. I DON'T KNOW

10. Which is the cleanest-burning fossil fuel?

A. Coal
B. Natural Gas/Propane
C. Petroleum
D. I DON'T KNOW

11. Which fossil fuel has almost half of its supply imported from foreign countries?

A. Natural Gas
B. Petroleum
C. Coal
D. I DON'T KNOW

12. Liquid propane is used instead of natural gas in fueling hot air balloons, recreational vehicles, in suburban areas, and on many farms. Why is propane often used instead of natural gas?

A. It's safer
B. It's more portable
C. It's cleaner
D. I DON'T KNOW

13. The major use of coal today in the United States is to...

A. make electricity.
B. fuel trains.
C. heat buildings and homes.
D. I DON'T KNOW

Electrical Energy

14. One kilowatthour of electricity will operate a television set for about six hours, or run a hair dryer during normal use for about five days. In 1989, what was the average price for one kilowatthour of electricity?

A. $0.08
B. $0.58
C. $1.08
D. I DON'T KNOW

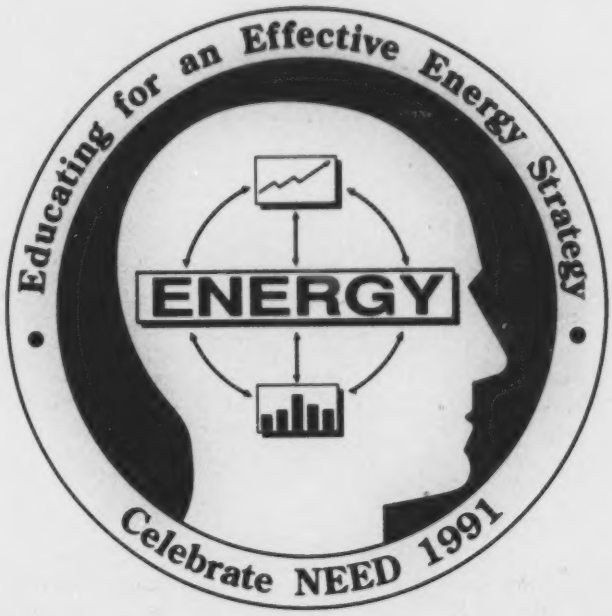
15. Which energy source was responsible for generating over half the nation's electricity in 1989?

A. Coal
B. Uranium (nuclear)
C. Hydroelectric power
D. I DON'T KNOW

16. Uranium is used to make electricity in a nuclear power plant. The uranium atoms give off energy when:

A. they combine and give off heat energy.
B. they split and give off heat energy.
C. they are burned and give off heat energy.
D. I DON'T KNOW

NEED Youth Awards Program for Energy Achievement



Contest Rules and Guidelines

Directed by the National Energy Education Development Project

NEED Youth Awards Program for Energy Achievement

Eligibility

Competition in the Youth Awards program is open to students in grades K-12.

Students in grades K-4 will compete on the Primary Level.
Students in grades 5-6 will compete on the Elementary Level.
Students in grades 7-8 will compete on the Junior Level
Students in grades 9-12 will compete on the Senior Level.

To enter a project in the Awards Program, you must submit a written project report. See the information under **Judging Criteria** on page 3 of this booklet for details on preparing a report.

Project Categories

There are two project categories: Multi-Activity and Single Activity. These two types of projects are described in detail below; however, please note that while both projects are eligible for statewide awards, *only Multi-Activity Projects are eligible to receive the NEED National Award for Outstanding Energy Achievement.*

Category 1 - Multi-Activity Project

Entry in this category is limited to projects involving the entire school and/or community. A Multi-Activity project is usually directed by a school's NEED committee. NEED committee members may be part of the same class, club, or student council, or they may be a collection of students from all grade levels who are interested in energy education.

To qualify as a Multi-Activity project, your project should be directed toward achieving several goals. The school committee may either be directly responsible for NEED activities, and/or prompt other classes and clubs to undertake energy education projects. Multi-Activity projects may develop goals similar to those listed below and/or to the goals listed under the Single Activity Project.

Sample Goals

- Prompt all members of the faculty to teach at least one energy-enriched lesson during NEED Week.
- Conduct a pre- and post-NEED Energy Education Poll of students and adults.
- Coordinate a NEEDay Energy Fair containing both student-made and commercial information booths and exhibits, live presentations, energy games, movies, and workshops.
- Invite neighboring schools to attend your school's NEED '91 celebration and encourage them to participate in NEED '92.

Category II - Single Activity Project

This category is designed for any energy education project undertaken by a class, club, youth organization, or collection of students. The Single Activity project may be part of a larger school/community effort, or an independent activity in a school that is not participating in NEED on a schoolwide basis.

A Single Activity project is usually directed toward achieving a single goal rather than several goals. The goals listed below are examples of activities that a group could develop for its NEED project.

Sample Goals

- Establish an energy information center that houses books, magazine articles, pamphlets, and other energy-related materials.
- Identify ten homes in the community that are in need of weatherization, and whose residents are on low or fixed incomes. Then secure the skills and supplies to weatherize the homes.
- Write an energy feature column in each issue of the school newspaper.
- Conduct a simulation of a U.S. Senate Energy Hearing for presentation to social studies classes and the community.
- Produce a 15-minute slide/videotape presentation on an energy source or issue.
- Adopt a lower-grade class or classes, and prepare an energy lesson for presentation during NEED Week.
- Publish an energy newspaper for distribution to students and the community during NEED Week.
- Establish an ongoing aluminum and paper recycling program for the school and/or community.
- Conduct a television-style game show using energy categories and questions for competition between class teams.
- Collect energy-related items appropriate for burial in a time capsule which show the role of energy in today's world, and its predicted role in the year 2001.
- Develop a home energy conservation contract and get 100 homeowners in the community to agree to practice the conservation measures suggested in it.
- Conduct an Energy Rock Video contest, and encourage student groups to enter their energy rock hits.

Judging Criteria

In each state, a review panel consisting of students, educators, business people, government officials, and members of energy organizations will judge the Multi-Activity and Single Activity Projects. The criteria listed below will give you a very specific idea of what your project should encompass. Consider these when you plan your project, and when you write your project report. Don't forget to fill out a Reporting Form for each of your project's goals – duplicate extra forms as needed.

Criterion I - NEED '90 Goals (0-15 points)

What is the goal of your project? A statement of your project's goal should outline the major achievement(s) that you tried to attain rather than list specific activities. For example, a goal for a project might be to establish an ongoing aluminum recycling project. It would not be a list of activities such as making posters, distributing flyers, or presenting a debate on mandatory recyling.

Criterion II - NEED '90 Activities (0-50 points)

Now you can list your activities. For this criterion, your project will be judged on whether your activities helped you reach your project's goals. While your project's goal may be ambitious, your project's activities should be achievable.

Criterion III - Resource Utilization (0-20 points)

Judges will look to see whether your project made use of available resources. Resources you can use include books, films, and other printed resources as well as knowledgeable people in your school or community. Be sure to describe how you contacted any people you used as a resource, i.e., by telephone, in person, or by letter.

Criterion IV - Project Evaluation (0-15 points)

Evaluate your project in order to determine its effectiveness in reaching its goal. Evaluation tools include surveys and questionnaires.

Documentation

Your project report can include any materials or information (news clippings, pamphlets, workshop programs, surveys, scrapbooks, etc.) that illustrate what your project encompassed. *You must, however, limit your documentation to 15 pages (may have text on both sides). The pages must be no larger than a typical photo album page.* Videos will not be used as judging criteria. (Note: If you want your report returned to you, include a self-addressed envelope with the correct postage.)

Entry Deadline

Your project report and documentation must be mailed to your state NEED Committee no later than April 12, 1991. Mail your report directly to NEED Headquarters ONLY if your state does not have a coordinator.

Other Guidelines

Project Advisor

Each project must have at least one adult advisor to oversee the project and to verify that the activities have been successfully completed. The advisor should not assume total responsibility for the project. In addition, an advisor may help students prepare the final project report, but he or she must not become the report's sole author. Teacher-written reports will not be considered by state review panels.

Start Early

Start your project early and complete as much of the report as possible before NEEDay. For example, your project's goals can and should be written several months prior to NEEDay, therefore satisfying Criterion I. In addition, other parts of the project report can be written in draft or final version beforehand. Sample project reports are included at the back of this booklet. Remember, the deadline for all projects is April 12, 1991.

School NEED Committees should offer assistance to any class, club, or student/youth group that is writing a Single Activity Project Report. NEED Committees should also duplicate all or part of this awards booklet, and distribute it to the groups well ahead of the deadline.

Excuses, Excuses...

Each year many schools participate in NEED but don't submit a report for the NEED Youth Awards Program. Some of the reasons we hear for not submitting a project include:

- *"We didn't do enough to submit a report."* Most schools start with energy projects for one or two classes during their first year in NEED, and then expand to do school-wide and community-wide projects in the following years. If your school did more with energy education this year than last, then you did enough to get recognized by the state committee.
- *"We didn't do our energy unit during NEED Week."* While many schools like to celebrate NEED at the same time as schools across the country, it isn't always possible to study energy during March. As long as you submit your project report by the April 12,1991 deadline, it doesn't matter when your energy activities took place.
- *"We can't possibly get a report together."* If you feel desperate at the thought of putting together a report, call the NEED Project collect at (703) 860-5029 for assistance.

The Awards

Youth Awards for Excellence (Category I and II)

Projects on all grade levels and in either Category I or II that are awarded 60 or more points at the state level will receive a school NEED Youth Awards for Excellence certificate. Each member of the project will also receive a certificate.

State and National Awards (Category I)

The top 12 Multi-Activity Projects in each state (three from each level) will receive State NEED Youth Awards for Excellence plaques. In addition, each member of a statewide award-winning project will receive a certificate.

The State Committee will then select one to three (number will vary depending on the state) of the best projects from the Elementary, Junior, and Senior Levels to represent the state in the National Awards Competition and at the NEED National Recognition Ceremonies that will be held in Washington, D.C., in June 1991. All expenses to Washington for one student and one adult advisor from the winning project(s) will be paid.

State Awards (Category II)

The top 12 Single Activity Projects in each state (three from each level) will receive State NEED Youth Awards for Excellence plaques. Each member of a statewide award-winning project will also receive a certificate.

NEED Youth Awards Program for Energy Achievement

Project Report Form
(To be submitted with your project report)

Check project category:

_ *Multi-Activity Project*
_ *Single Activity Project*

Check project level:

_ *Primary Level (K-4)*
_ *Elementary Level (5-6)*
_ *Junior Level (7-8)*
_ *Senior Level (9-12)*

Project Title

School/Group Name

Street Address

City/Town | County/Parish | State | Zip Code

Area Code/Telephone Number | U.S. Congressional District

Project Advisor | Student Director

No. of students coordinating project | School Principal

No. of students your project reached | No. of community members your project reached

I, _____ *and I,* _____
(Project Advisor) (Student Director)

declare that the attached project report has been written and assembled with the participation of students and that all information and data presented in this report are true.

Date _____

Submit this form along with your project report to NEED Headquarters by April 12, 1991.

NEED YOUTH AWARDS PROGRAM FOR ENERGY ACHIEVEMENT

REPORTING FORM

Goal # _____
Activities:
Resources:
Evaluation:

NEED YOUTH AWARDS PROGRAM FOR ENERGY ACHIEVEMENT

REPORTING FORM

Goal # SAMPLE

To prompt all members of the faculty to teach at least one energy enriched lesson during NEED Week.

Activities:

- Obtained permission from principal to conduct activity.
- Prepared information for teachers and administrators and put flyers in each teacher's box.
- Secured curriculum material for teachers to use and distribute at faculty meeting.
- Secured free/discount coupons for pizza and ice cream as incentives for teachers to participate.
- Put up posters in faculty lounge.
- Made presentations at faculty and department meetings.
- Spoke to teachers individually to encourage participation.
- Developed evaluation system to identify teachers who participated.
- Followed-up with thank you notes and prizes to teachers who participated.
- Evaluated all aspects of the project.

Resources:

- Had social studies teachers use the Let's Talk Energy Show, Energy Group, Senate Energy Hearings and other NEED items.
- Received teacher activity units from electric and gas utility companies and the State Energy Office.
- Worked with the English and Math departments to develop energy related English and Math lessons.

Evaluation:

- Developed an evaluation form which was distributed during a faculty meeting.
- Spoke to teachers on an individual basis to determine the success of the project.
- Sixty-eight percent of the faculty participated in the project.
- Of those participating, most teachers said they would take part in the project again.

NEED YOUTH AWARDS PROGRAM FOR ENERGY ACHIEVEMENT

REPORTING FORM

Goal # SAMPLE 2

To collect energy related items appropriate for burial in a time capsule which show the role of energy in today's world and it's predicted role in the year 2005.

Activities:

- Had a brainstorming session and came up with suggestions on what to include in a capsule.
- Came up with graphs showing today's energy sources (percentages, barrels of oil, tons of coal, cubic feet of natural gas, etc.).
- Made graphs for 1990 and the year 2005 using research findings and predictions from guest speakers.
- Wrote editorials, point/counterpoints, and articles on nuclear power, acid rain, automobile mileage requirements, the 55 mph speed limit, and other subjects.
- Wrote visions of our energy future in 15 years from now.
- Chose to unearth capsule in 15 years and assigned class officers different responsibilites for the future unearthing.
- Went to local veterinarian, who donated a small casket to use as a time capsule.
- Had an official burial ceremony, attended by the school and local newspapers, the school's principal, and all the school's classes.
- Recorded the burial in the school's records and put in a reminder to unearth the capsule in 15 years.

Resources:

- Used the Department of Energy's Energy Outlook to 2010.
- Consulted Conoco and Chevron's Energy Outlook to the Year 2000.
- Obtained Congressional testimony on future energy trends.
- Invited guest speakers to class and conducted personal and telephone interviews with a renewable energy expert and representatives from coal, petroleum, natural gas, and electrical utility companies.

Evaluation:

- Used the NEED Energy Education Poll as a pre-test and post-test.
- Student's knowledge score from the five social studies classes was 2.6 out of 12 before the activity and jumped to 11.1 after the project – fewer students chose the I DON'T KNOW choice on the opinion questions after the activity.

Great Energy Rock Performances

(Teacher's Guide)

Goal: To conduct a contest in which student groups perform energy songs.

Before You Begin

Teachers, this activity is appropriate for grade levels four through twelve. You can expect this activity to take between three to five class periods.

Before you begin this activity, make sure you have read the teacher's instruction sheet in the front of the NEED Activities guide. This sheet gives you general instructions and suggestions for conducting all NEED activities. It's an invaluable resource.

The Group Contract: Your students must read the Group Contract instructions sheet that is included near the front of the NEED Activities Guide. The instructions tell students what's expected of them, helps them to write their own contract (students support that which they help create) and has them agree to work together as a team on a common project.

Background

Energy rock performances is a great energy education program that is enjoyed by students and adults alike. In this activity, student groups research assigned energy topics, write and perform their own energy songs, create a look (using costumes, scenery, and props), and design an album cover. Student groups usually compete against each other for the Number One ranking. Great Energy Rock Performances can be prepared during several class periods. You can lessen the time students spend on this in class by making some of the assignments homework.

Getting Organized

STEP 1 There are a few decisions you should make before you get your students started on this project. First, decide whether you want your students to present their performances in class for their classmates, or if you want other classes to get into the act. Keep in mind, too, that all the students at your school will probably enjoy and learn from watching these energy performances so think about a school-wide presentation time.

Next decide who you want to judge the performances. If your students will just be performing in your class, then you can be the sole judge of the activity. If more of the school is involved then you might consider having a panel of judges to evaluate student performances. Music teachers and local disc jockeys make excellent judges for musical performances. Judging is further described in Step 8.

STEP 2 Decide on what and on how many energy topics you want your students to work on. There are easily a dozen energy topics you might choose from. You can select topics from the energy fact sheets in the NEED Resources guide, or you can select your own.

STEP 3 Now that you have selected the topics for the energy rock groups gather resource materials for your students to use. Along with NEED Resource fact sheets, put together any books, magazine articles, or pamphlets that might provide additional information.

STEP 4 At this point you may wish to assign your students to groups or let students form their own groups. It's best to keep student groups small. Groups of four work well but you are the best judge. Structure the groups according to your experience and expertise with the cooperative learning model.

STEP 5 Make copies of the following materials for your students. NEED recommends one copy for each student.

- Group Contract Directions.
- Student copy of Great Energy Rock Performances activity packet.
- The appropriate NEED Energy Fact Sheets.

STEP 6 Get the ball rolling. Introduce the project to your students. Assign groups or let students choose their own groups. Pass out materials. Serve as a consultant. Once again, you can expect this activity to take between three to five class periods. You can lessen the time students spend on this in class by making some of the assignments homework.

STEP 7 Once your students are underway with their projects, your main tasks will be guiding students and grading their assignments. As for grading, you can create your own grading scheme or you can follow the scheme outlined below.

Sample grading scale:

Assignment 1 (Answering questions)	10 points
Assignment 2 (Listing facts)	10 points
Assignment 3 (Energy song)	35 points
Assignment 4 (Interview)	30 points
Assignment 5 (Album cover)	15 points
Energy Performance	100 points
TOTAL POINTS	200

STEP 8 Now it's time for the student performances. As host of the show, you'll need to coordinate student performances, interview groups after their performances, and arrange for the judging. You, of course, are the natural choice to be the host of the show but you might also choose to have someone else officiate. If you have arranged a panel of guest judges, you will want to make tally sheets for the judges to use as they grade the performances. A sample tally sheet/judging guide is given on the reverse side of this page.

STEP 9 Videotape the rock performances and play the best performances in the school cafeteria during lunch, or arrange for a local television station to play them.

Great Energy Rock Performances

(Student Sheet)

Goal: To create and perform your own live stage production of a song about an energy source or about energy conservation.

Before You Begin

Things to Keep In Mind:

- Make sure everyone in your group has signed the group contract.
- Make sure everyone in your group understands and participates in the group's project.
- Hand in all assignments on time. An *** by a paragraph means that an assignment must be handed in to your teacher.
- Write all assignments, reports, and scripts neatly, and check them for spelling, punctuation, and grammar.

Background

Your group has been assigned the task of researching an energy source then composing and performing a song about that source. You will also create a look for your group in the design of an album cover, costumes, and scenery. Do your best as you will be competing for prizes against other student groups in your school and possibly against other schools in your region and state. Judges will award points for your display of energy knowledge, idea originality, and enthusiasm.

How To Begin

TASK 1
Getting Started

You should have in your possession one assigned energy source topic, fact sheets about your energy source, several sheets explaining Great Energy Rock Performances, and a sample performance to use as a guide. If your group has all of the essential parts then continue reading. If not, see your teacher.

Step 1: Before you do anything else, take out the "sample" Energy Rock Performances sheet. Have one person read through the sample – section by section – while the other members follow along silently. Read and listen carefully because later as a group you'll have to answer five questions about coal.

Step 2: You'll notice from the sample that this particular energy rock group, like any other popular band, has a name (Coal and the Gang), a hit single, and an album. This band sings a song that parodies (imitates or follows) the familiar song, "I've Been Working on the Railroad." Compare the original lyrics to the new energy lyrics about coal. Notice how they are alike and different.

The sample energy song is similar in rhyme and rhythm to the original version. It not only entertains but tells the audience seven facts about coal. (Remember! Your energy song must do the same; it must tell some facts about your energy topic.)

Now, reread the sample introduction and the song. LIST on a separate sheet of paper nine facts about coal. Hold on to this paper. There will be more to add to it before turning it in to your teacher.

Step 3: Next, read the section marked Interview. This is a section that you'll be asked to create on your own in a later step. It is an interview between the host (your teacher, a local D.J., your principal, etc.) and your energy rock band.

Notice that both the sample questions and answers tell the audience more information about coal. For instance, Dick Clark's first question lets us know that coal is the second most used source of energy in the U.S. (What's the first most used source? Petroleum – you're correct!) Digger's answer supplies the audience with two additional facts about coal. Can you find them? You're right again! Eighty percent of all coal produced in the U.S. is bought by our own electric power plants – ten percent of our coal is exported abroad.)

Now go back to the list of coal facts you were writing down. Add to your list – look for information from the interview, too. All together there are 28 facts about coal. How many did you find? ***Keep this list to turn into your teacher later.

No, you're not quite ready to start yet. Before your group actually gets down to work let's see if you've been paying attention. Answer the five following questions concerning coal.

***Do this individually and turn your answers in to your teacher along with your group's list of coal facts.

Coal Questions

1. What major chemical element is removed from coal in order to reduce air pollution?
2. Name the top five producing states.
3. Of the coal that is mined in the United States what percentage is used by electric companies to generate electricity?
4. At our present rate of usage, how many years of coal reserves does the United States have left?

Judging Guide

Instructions

The following information will help you evaluate student groups on Great Energy Rock Performances. Keep this information in mind as you watch the student groups perform. You can score each group in the space provided at the bottom of this page. Here are the categories you will be judging the groups on.

1. **Energy Group Name:** (0 to 10 points) How well does the group's name fit its energy source?
   Excellent: 9-10 points Good: 7-8 points Fair: 4-6 points Poor: 0-3 points

2. **Energy Song/Facts:** (0 to 40 points) Does the song tell the audience at least five facts about the energy source? How well does the energy song follow the rhyme and rhythm of the original tune?
   Excellent: 35-40 points Good: 25-34 points Fair: 15-24 points Poor: 0-14 points

3. **Energy Interview:** (0 to 20 points) Do both the questions and the answers tell the audience something about the energy source? Does the interview mimic a real rock interview?
   Excellent: 18-20 points Good: 15-17 points Fair : 10-14 points Poor: 0-9 points

4. **Album Cover:** (0 to 10 points) Does the album cover demonstrate a knowledge of the energy source? Does it relate to the lyrics of the energy song? Is it creative?
   Excellent: 9-10 points Good: 7-8 points Fair: 4-6 points Poor: 0-3 points

5. **Group Performance:** (0 to 20 points) Are you able to hear and understand the lyrics to the energy song? Do all the members of the group know their parts? Did the group teach you several facts about their energy source? Were the costumes, props, and scenery appropriate for the energy source? What was your overall impression of the group's performance?
   Excellent: 18-20 points Good: 15-17 points Fair: 10-14 points Poor: 0-9 points

---

Tally: Score the groups here as they perform.

Group 1 _____

1. Name:_____ points
2. Song/Facts:_____ points
3 Interview: _____ points
4. Cover:_____ points
5. Performance: _____ points

TOTAL POINTS: _____

Group 2 _____

1. Name: _____ points
2. Song/Facts: _____ points
3. Interview:_____ points
4. Cover: _____ points
5. Performance:_____ points

TOTAL POINTS: _____

Group 3 _____

1. Name: _____ points
2. Song/Facts: _____ points
3. Interview: _____ points
4. Cover: _____ points
5. Performance: _____ points

TOTAL POINTS: _____

Group 4 _____

1. Name:_____ points
2. Song/Facts:_____ points
3 Interview: _____ points
4. Cover:_____ points
5. Performance: _____ points

TOTAL POINTS: _____

Group 5 _____

1. Name: _____ points
2. Song/Facts: _____ points
3. Interview:_____ points
4. Cover: _____ points
5. Performance:_____ points

TOTAL POINTS: _____

Group 6 _____

1. Name: _____ points
2. Song/Facts: _____ points
3. Interview: _____ points
4. Cover: _____ points
5. Performance: _____ points

TOTAL POINTS: _____

Energy Rock Sample Performance

To give you an idea on how to create your group's energy song and performance, here's a clip from a recent *Energy Bandstand* show. Let's listen in!

Introduction

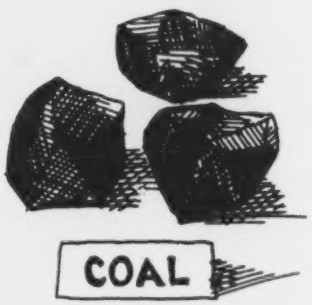
(The scene is a band stage. The host of the show addresses the audience.)

Dick Clark: It's my pleasure to introduce our next energy band. This is the group that fueled the nation's industrial revolution. A group that's been producing one-third of its songs in underground studios and two-thirds of them in surface studios. Let's give a big Bandstand Welcome to "Coal and the Gang" singing their new hit single, "I've Been Working on the Railroad" from their latest album, Coal Train.

Original

I've been working on the railroad
All the livelong day
I've been working on the railroad
Just to pass the time away

Can't you hear the whistle blowing
Rise up so early in the morn
Can't you hear the whistle blowing
Dinah, blow your horn



Parody

I've been working on the railroad
Moving coal all day
My next stop is a power plant
Where coal's burned a clean way

Can't you see the lights aglowing?
Burning coal so early in the morn?
Can't you see the motors going?
'Lectricity is now the form

Interview

(The band has finished its performance. Now the host of the show interviews the band.)

Dick Clark: That was great, guys. Step right over here and let me ask you a few questions. First of all, Digger, I know that Coal and the Gang is the second most popular energy group in the nation right now, just after petroleum. You've heard the group – Bo Bo Derrick and the Drillbits. Can you tell me who buys most of your energy albums?

Digger: Well, Dick, about 80 percent of our albums are bought by electric power plants. They think we generate some really powerful tunes. We're even popular overseas. Over ten percent of our tours are outside the United States.

Dick Clark: How do you answer your critics who say your energy music is dirty and pollutes the airwaves?

Shaft: That used to be true, Dick, but we've really cleaned up our act in the last 15 years. Now we try to remove all the sulfur from our songs, before, during, and after our concerts. We've recently developed some new technologies in our studio to become an even cleaner energy band. Now even our old critics admit we're pretty clean.

Dick Clark: I know you guys are an all-American band. Can you tell me what states the members of the band come from?

Scrubber: In order, we are from Kentucky, West Virginia, Wyoming, Illinois, and Pennsylvania.

Dick Clark: One last question. You guys have been around for a long time now. How long do you think your popularity will last considering you're a nonrenewable energy band?

Digger: If people continue buying our energy albums at the rate they did in 1989, we'll be around for another 300 years.

5. In the United States, how much coal is produced from underground mines? From surface mines?

TASK 2
Read Before You Write

You're almost ready to begin, but before you can effectively teach someone about your energy source you'll have to do some researching on your own.

Step 1: Take out the NEED Fact Sheets on your energy source – given to you by your teacher. Read each boldfaced section one at a time, stopping as a group to brainstorm and highlight important facts – facts your group's name, song, interview, etc. will eventually teach the audience. Try to pick out 15 to 20 of the most interesting or telling facts about your energy source and list them on paper.

***Hand this list in to your teacher. Make a copy of this list for your use as well, or seek your teacher's approval immediately and then proceed ahead!

TASK 3
Name that Group

Now that your group knows something about your energy source select a name for your group. Work together to brainstorm at least five possible names for your group. Discuss their positive and negative elements. Remember from the sample that the coal group was known as "Coal and the Gang" – the petroleum group was called "Bo Bo Derrick and the Drillbits." Be clever, be creative, be original!

***Let your teacher know you've named your group.

TASK 4
Choose that Song to Parody

Step 1: Begin by brainstorming ten songs that your group could write your own energy source lyrics to. You don't have to use a rock song; you can use a folk tune, a theme song from a television show or commercial, a nursery rhyme, or a rap. Don't worry about all the little details now, but from the ten tune titles which three will most easily adapt themselves to your energy source topic?

Step 2: Take those three titles and the first couple of lines or verses and brainstorm some lyrics of your own. If you get stuck, look back at the sample "I've Been Working on the Railroad." Remember your words must imitate the rhyme and the rhythm of the original.

TASK 5
Write that Tune

As a group, settle on just one song from the three choices. Choose the one that flows the best. Now, using your list of facts begin writing your own group song following the form of the original tune. Do one line at a time. Keep in mind that your energy song must tell at least five facts about your source. If you can add more, terrific!

***Hand in your completed song to your teacher. Be ready to revise if necessary.

TASK 6
Write a Pre-performance Introduction

You're moving right along. Your next task is to write a short three to four sentence introduction that the host will read to the audience before your grand entrance. Like the song, it too should pass along several important facts about your energy source. In fact, this is a great way to tell the audience some facts about your topic that didn't seem to fit the lyrics.

Keep the introduction short and again – try to be clever, creative, and original.

***Turn a copy of the introduction in to your teacher.

TASK 7
Prepare the Post-performance Interview

You're lucky! Not everyone gets to write both the questions and the answers to their own interview. By doing this you'll get to control what information you want your audience to know. Keep in mind that both your questions and answers should say something about your energy source. Look back at the sample sheet or to your group's fact list for ideas. Notice, too, that we gave the members of our band appropriate nicknames for a coal group. You might try to do the same for your group.

Since time may be limited during the show, put a star by the four questions you especially want the host of Great Energy Rock Performances to ask during the interview.

***Hand in a copy of the group's interview to your teacher. Revise if necessary.

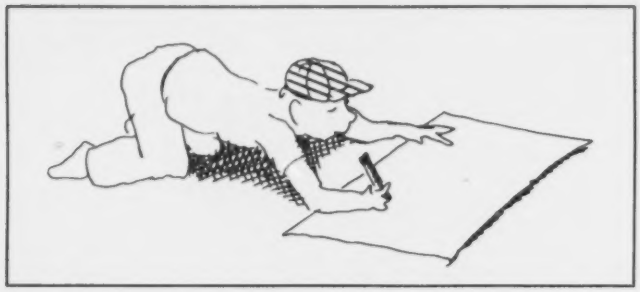
TASK 8
Design an Album Cover

Step 1: Using the name of your group and your hit single, design an album cover that reflects your energy topic. For example, a uranium group called the Atomic Splits could design

an album cover featuring its hit single, "I'm Losing Mass Over You" with a picture of a neutron splitting an atom of uranium. Be creative. Brainstorm five ideas. Discuss all five and choose one. Sketch out the album cover idea and provide a written rationale (explanation) for the selection.

***Turn your album sketch and rationale in to your teacher.

Step 2: Take the group's idea and work together as a group or assign an individual(s) to bring the sketch to life. While one or more group members work on the album cover, the remainder of the group can move on to Task 9.



Task 9
Props, Costumes, and Scenery

Now it's time to develop a look for your group. Props, costumes, and scenery will help you get your point across to the audience. For example, members of a solar group could all wear yellow clothing and sun glasses. Members of a conservation-on-the-road group might have oily-black faces and be in costume as a tire pressure gauge, an oil filter, spark plug, etc. Members of a hydroelectric group might create some scenery by making a backdrop that shows the water cycle.

Steps 1 & 2: Brainstorm ideas for props, costumes, and scenery. Explore all possibilities. Once you've settled on a plan of action, assign various jobs to group members. Someone might be responsible for locating props, someone else to paint scenery, etc. Don't procrastinate. Keep the performance date in mind.

TASK 10
Rehearse Again and Again and...

Rehearse the performance as many times as possible. Ask your teacher or other groups to watch your performance so you can get some suggestions. Critique each other but don't be overly critical. Offer positive comments to help somebody's performance – compliment them for efforts well done. Some things to watch for as you or other groups perform are listed below.

1. Is the group loud enough so that everyone in the audience can hear and understand the song?
2. Are the scenery, costumes, and props appealing and appropriate?
3. Is the group enthusiastic in its delivery?
4. Does everybody know his or her part?

If your school has some video equipment, consider taping your rehearsals. Don't be afraid to add movement to your performance; dancing and planned steps will enhance your program.

TASK 11
Evaluation

Step 1: Preparing a pre- and post- quiz.

Prepare a pre- and post-quiz on your energy area to determine if your group was effective in teaching about your energy source. You can use the same answer sheet for the pre-and post quiz by dividing it into two sections, one for the pre-performance answers and one for the post-performance answers. Your teacher could even use your quiz as part of a final test on this unit. To get you started, here is a sample quiz on Coal and the Gang's performance.

1. Coal is the _____ provider of energy in the United States.
   a. biggest
   b. second
   c. third
   d. fourth
2. The major use of coal today is to
   a. generate electricity.
   b. fuel trains.
   c. heat homes.
   d. manufacture steel.
3. Which chemical element found in coal can pollute the air?
   a. carbon
   b. oxygen
   c. iron
   d. sulfur
4. At present rate of use, how many years of coal does the United States have left?
   a. 50
   b. 100
   c. 300
   d. 1000
5. Most coal produced today is mined
   a. underground.
   b. at the surface.

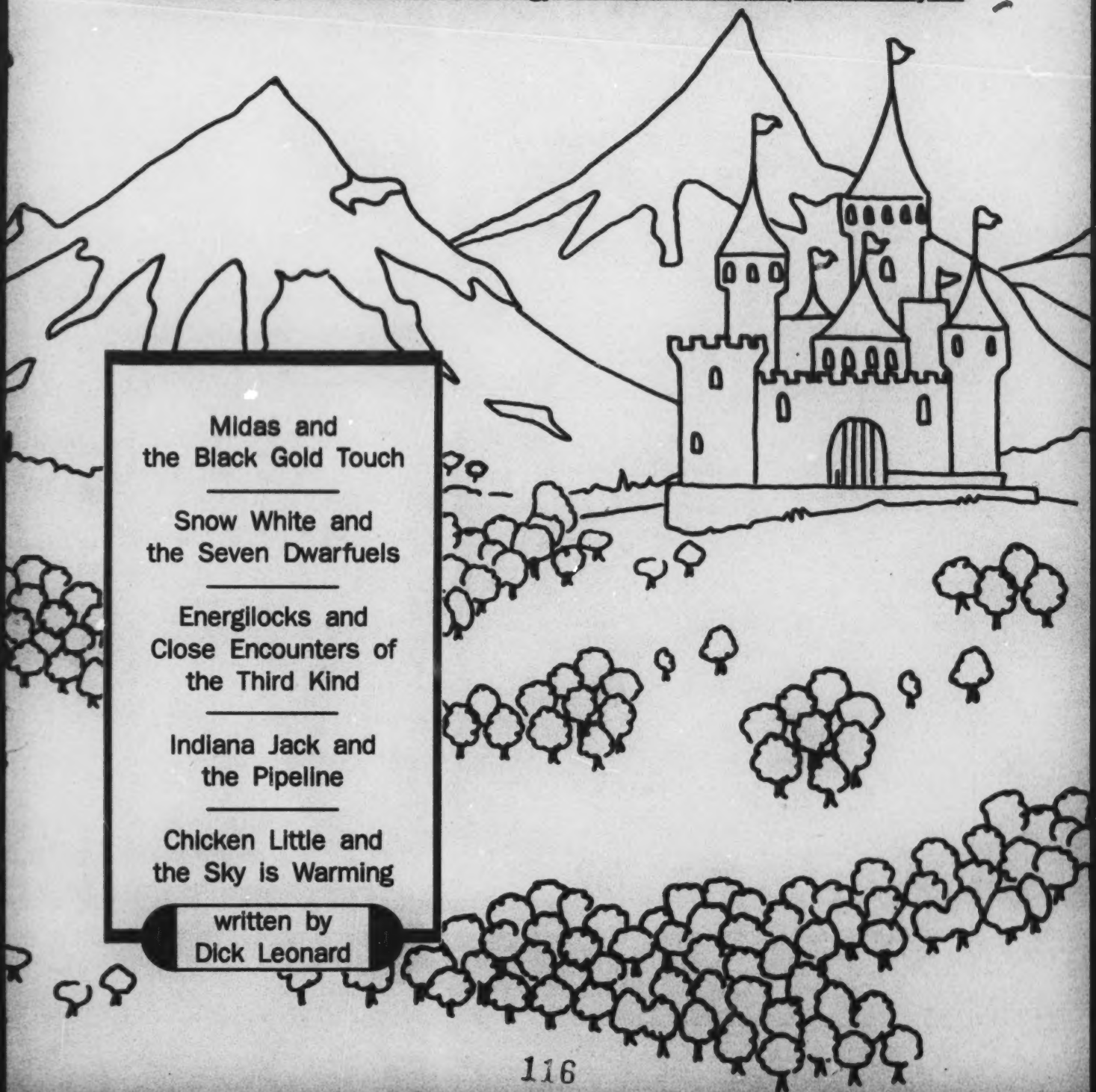
Note: Your quiz questions should be made up from information directly presented to the audience in the song, the group's name, the introduction, the interview, props, costumes, etc. You can safely ask about any information that your group chose to pass along in one of the activities.

TASK 12
Break a Leg!

The big day is here! Your group's performance is next. When it's your turn to perform, the host will introduce your group (using your introduction). It's up to you to display your album cover, name your hit single, and perform your song. After your performance, be ready to answer your interview questions. As they say in show business, break a leg!

The Incredible Energy Tales

Published by the National Energy Education Development Project



Midas and
the Black Gold Touch

Snow White and
the Seven Dwarfuels

Energilocks and
Close Encounters of
the Third Kind

Indiana Jack and
the Pipeline

Chicken Little and
the Sky is Warming

written by
Dick Leonard

TABLE OF CONTENTS

The Energy Entertainment Guide 3

Midas and the Black Gold Touch 5

Snow White and the Seven Dwarfuels 7

Energilocks and Close Encounters of the Third Kind 9

Indiana Jack and the Pipeline 12

Chicken Little and the Sky Is Warming 14

NOTE:

Teachers, you may wish to use the Energy Entertainment Guide found on page three of *The Incredible Energy Tales*. The guide can be used by students in previewing the play to determine important factual information.

The Energy Entertainment Guide contains five multiple-choice questions for each scene of the play. You may wish to hand out the Energy Entertainment Guide before the play begins. This will allow the audience time to review the five questions for the scene they are about to see. Once the scene is completed, the audience should answer the questions for that particular scene, as well as review the questions for the next scene.

Space has been provided at the top of the guide for any instructions you may wish to give the students. You may decide to have the students put their name and class at the top of the page. Decide if you want to give prizes to students who get three or fewer answers wrong.

ENERGY ENTERTAINMENT GUIDE ANSWERS

Midas and the Black Gold Touch
1. C 2. C 3. A 4. C 5. D

Snow White and the Seven Dwarfuels
1. A 2. A 3. B 4. D 5. A

Energilock and Close Encounters of the Third Kind
1. B 2. B 3. B 4. A 5. B

Indiana Jack and the Pipeline
1. B 2. B 3. C 4. B 5. C

Chicken Little and the Sky Is Warming
1. A 2. C 3. D 4. D 5. C

The Energy Entertainment Guide

NOTE: **Completely** darken the circle that best completes the sentence or best answers the question. For example:

(a) ● (c) (d)

Midas and the Black Gold Touch

1. Which of the following states is NOT one of the top five petroleum producing states?
   (a) Oklahoma (b) California (c) Michigan (d) Louisiana
2. In 1989, what fraction of U.S. Petroleum was imported from other countries?
   (a) 1/4 (b) 1/3 (c) 1/2 (d) 2/3
3. Approximately, what percent of the nation's domestic petroleum supply comes from offshore wells?
   (a) 10% (b) 25% (c) 40% (d) 50%
4. Out of every 100 barrels of petroleum, how many are used to fuel the nation's cars, trucks, buses, trains, boats and planes?
   (a) 25 barrels (b) 45 barrels (c) 65 barrels (d) 80 barrels
5. Which of the following items is made out of petroleum?
   (a) Plastics (b) Rubber (c) Vinyl (d) All three items

Snow White and the Seven Dwarfuels

1. In 1989, what percent of the nation's electricity was provided by hydroelectric power?
   (a) 10% (b) 25% (c) 45% (d) 60%
2. If all the wind machines in California were to stop operating, the amount of wind generated electricity in this nation would decrease by a:
   (a) large amount (b) moderate amount (c) small amount
3. Geothermal energy gets its energy from:
   (a) the sun (b) the earth (c) splitting atoms (d) burning garbage
4. Solar energy can be used to:
   (a) produce electricity
   (b) heat homes
   (c) produce biomass
   (d) all three jobs
5. Which alcohol fuel can be used as a transportation fuel, and is made from biomass (chiefly corn)?
   (a) ethanol (b) methanol (c) penthanol (d) propanol

Energilocks and Close Encounters of the Third Kind

1. Which energy job uses the greatest amount of energy in the American home?
   (a) lighting
   (b) heating/cooling rooms
   (c) heating hot water
   (d) I DON'T KNOW
2. For the same amount of light, fluorescent lightbulbs, compared to incandescent bulbs, use:
   (a) more energy (b) less energy (c) about the same amount of energy
3. The average new car gets approximately how many miles to the gallon?
   (a) 13 mpg (b) 26 mpg (c) 36 mpg (d) 51 mpg
4. If you will be waiting in your car for just 60 seconds, turning off the engine will:
   (a) save energy (b) waste energy (c) make no difference
5. What fraction of a home's energy is used to provide hot water?
   (a) 1/10 (b) 1/5 (c) 1/2 (d) 2/3

Indiana Jack and the Pipeline

1. The major method for transporting natural gas is by:
   (a) truck (b) pipeline (c) boat (d) train
2. The chemical name for natural gas is:
   (a) ethane (b) methane (d) propane (d) octane
3. In 1989, what fraction of the homes in the United States were heated by natural gas?
   (a) 1/10 (b) 1/5 (c) 1/2 3/4
4. Many people are suggesting that more natural gas be used instead of coal and petroleum in the future. This is because natural gas is:
   (a) the nation's most abundant fossil fuel
   (b) the cleanest of the fossil fuels
   (c) the cheapest source of heat energy
   (d) all three of these reasons
5. Which sector of the United States economy uses the most natural gas?
   (a) homes (b) transportation (c) industry (d) stores and businesses

Chicken Little and the Sky Is Warming

1. What is the average cost of a kilowatthour of electricity?
   (a) $0.08 (b) $0.48 (c) $1.08 (d) $1.48
2. In 1989, what fraction of all of the energy consumed in the nation was used by power companies to generate electricity?
   (a) 1/10 (b) 1/4 (c) 1/3 (d) 1/2
3. Cogeneration power plants are more efficient because they:
   (a) produce more electricity
   (b) are cheaper to build
   (c) use less fuel
   (d) use waste heat for useful purposes
4. Which of the following sources of energy is responsible for generating over half the nation's electricity?
   (a) hydroelectric (b) natural gas (c) nuclear (d) coal
5. The peak demand for electricity during the summer months is between:
   (a) midnight to 6:00 a.m.
   (b) 6:00 a.m. - 12 noon
   (c) 12 noon - 6:00 p.m.
   (d) 6:00 p.m. - midnight

MIDAS AND THE BLACK GOLD TOUCH

King Midas of ancient Greece was given his wish that everything he touched would turn to gold. In the centuries that have past, the Midas family has lost its kingdom and today Minus, great, great, great, great, great grandson of Midas, owns and runs a restaurant in Jersey City, New Jersey.

(The scene opens with Minus looking through a box. Son Minos is doing his homework. Wife Addie is surveying the situation from the side.)

Minus: Minos, as soon as you finish that school report on petroleum, come and help me with this box of old stuff for the garage sale.

Minos: (*Enters holding book.*) Pop, it says here, petroleum is a non-renewable energy source. What does that mean?

Minus: It means oil is too precious to waste, it won't last forever – like my patience – now put that book down and help me!

Minos: We're having another lawn sale, Pops?

Minus: Yeah, and I found this real old stuff in the attic we might be able to sell.

Minos: Is the restaurant doing that bad?

Minus: Nobody wants good food anymore. All they want is fast food. Even the new sign I had made doesn't stop people from driving past.

Minos: Hey, Pops, here's a real old letter. It must be worth something. What does it say?

Minus: I don't know. It's all Greek to me. Go get your sister – she can translate it for us.

Addie: What now, Minus? Are you still looking for proof that you are the great, great, great, great, great grandson of King Midas?

Minus: Never mind that. Just ask Minnie to read this and tell me what it says.

Minnie: (*Upon entering, Minnie is handed the letter by her mother.*) It's a letter from somebody named Midas addressed to his descendants.

Addie: (*Looks amazed.*)

Minus: What Midas? King Midas?

Minnie: It doesn't say, but he must have been important. Here is a gold seal at the bottom.

Minus: Then it is true. What did I tell you?

Minos: We're rich, we're rich, we're rich, we're rich!!!!

Minnie: What do you mean, Pop?

Minus: There is a story in my family that King Midas was my great, great, great, great, great grandfather.

Minnie: The guy with the touch of gold? Awesome!

Addie: What does the letter say?

Minnie: It says this letter grants to the holder King Midas' power to touch anything and change it to the most valuable substance in the world.

Minus: Does it tell how to turn things into gold?

Minnie: Well, first it gives a warning. It says a person is wise who knows the true value of the things in the world. Then it says that if you simply touch an object when you say the words "Midas touch" that object will ...

Minos: ...be turned to gold. We're rich, we're rich, we're rich!!!

Minnie: It doesn't say gold, it says it will be transformed into the most valuable substance in the world.

Minus: Well, that's gold, isn't it?

Addie: I'm not so sure.

Minos: Sure, what else could it be, plastic??

(They all laugh.)

Minos: Try it, Pops.

Minus: OK. What should I try first?

Minnie: Well, rock stars have gold records, why don't we have one? Here is one of my LPs.

Addie: Be careful, Minus, remember what happened to your great, great, great, great, great grandfather Midas.

Minus: I'll be careful. All I have to do is pay attention to what I'm doing. (*Hugging Addie.*) The important thing is not to say...

Minnie/Minos: (*Shouting.*) Pops!

Addie: (*Shouting.*) Minos!

Minus: (*Picking up LP.*) Gotcha, thought I was going to say Midas touch. (*Minus drops LP as if it was hot.*)

Addie: What happened?

Minus: This isn't working. It didn't change into anything valuable.

Minnie: Maybe it doesn't work on everything.

Minus: Ask my great, great, great, great, great aunt. It worked on her. What's this record made of, anyway?

Minos: It's vinyl. Vinyl, according to my report, is made from petroleum.

Addie: Really? They make a lot of records – where does all the oil come from?

Minos: The big oil producing states are Alaska, Texas, Oklahoma, California, and Louisiana.

Minus: Enough already about oil. I want the stuff I touch to change into something of value. I have an idea. Hand me that bag. I will need it to put that gold in once I have figured out this Midas touch thing and ...

Minnie: A plastic bag?? Minos, isn't plastic made from ...

Minnie/Minos: Oil!!!

Minus: Is everything made from oil?

Minos: A lot is. We use so much oil in this country that we need to import about half of our supply from other countries.

Addie: Isn't our own oil good enough?

Minos: Sure, but we need so much that we even have to drill offshore for it. Twelve percent comes from offshore.

Minnie: Minos, Pop can't concentrate with all this noise – come on, Pop, try again.

Minus: OK... hmmmmm, I know. Give me a pair of Minos' old shoes. Most families have their children's shoes bronzed. Ours will be made golden by my Midas touch. ... Nuts!!

Addie: What now?

Minos: Sneakers! Radical, Pop. I've wanted a new pair of Reeboks for weeks. How did you know?

Minus: Will you stop that. Don't you see your shoes turned into sneakers, but, why?

Addie: And don't give us that oil bit again, because I know for a fact that sneakers are made from rubber, not oil.

Minnie: Not so fast, Mom. Today, most rubber is synthetic and synthetic rubber is ...

All: ...made from oil!!

Minus: I thought that, like coal, oil was just burned for energy?

Addie: No, coal provides one quarter of our energy, but oil gives us 41 percent. I typed Minos' report.

(Minos picks up a bottle of spring water.)

Minus: This is crazy.

Minnie: Let me read that letter again.

Minus: All this talk has made me thirsty. Let me have some of that water.

Minnie: Oh, Pops... Pops?

Minus: What? This Midas touch thing is worthless!

Addie: Minus, don't drink that!

Minus: Why?

Minnie: Pops?

Minus: What?

Addie: Because if I'm right, it is oil. (*She takes the glass and looks at it.*)

Minnie: Pops?

Minus: What?

Addie: Just as I thought. This Midas thing does work. But today, gold isn't the only valuable substance. In this country, oil is very, very valuable. Many call it liquid black gold.

Minnie: Pops?

Minus: What?

Minnie: It says in the letter that the magic touch ends at midnight.

101

Minos: You mean, we aren't going to be rich?

Minus: Well, I didn't need the Midas touch to tell me how valuable oil is. Oil is important enough to drive me out of business.

Minos: Yeah, it's the reason the restaurant is going broke – people in fast cars that run on gasoline want fast food and drive right past. In fact, almost two-thirds of all petroleum is used for transportation.

Minus: Kids, in this modern world, you don't need gold to succeed. All you need is brains. The Midas touch may be gone, but I have something better, an idea.

Addie: What is it, Minus?

Minus: If people in fast cars and living in warm comfortable homes want fast food, we'll give it to them. We'll give them good food fast. Addie, get me the sign painter on the phone.

Minnie/Minos: Why, Pops?

Minus: I have learned a lesson about the value of petroleum today, and we are going to use this important stuff called oil and put its energy to work for us.

Addie: I have the sign painter on the phone.

Minus: Tell him to come over and add something to our new sign.

All: What??

Minus: We deliver!!

SNOW WHITE AND THE SEVEN DWARFUELS

Once upon a time, before the Environmental Protection Agency, there was a Kingdom of Purestan. The kingdom was the cleanest and healthiest of all the kingdoms in the realm, because it used renewable energy sources. It was ruled by a wise king who chose his energy advisors well. The King's decisions about using renewables came from his renewable energy advisors – the Seven Dwarfuels. They knew the long term value of using clean renewable energy to provide Purestanians with the energy they needed. The King was so proud of his clean energy policy that he named his daughter Snow White, as a reminder and symbol of his wise energy and environmental decisions.

(The scene opens with the King pacing in his chamber as Drop, the Dwarfuel's chief advisor for hydroelectric energy, enters.)

Drop: You wanted to see me, Sire.

King: Where are the other Dwarfuel advisors I asked to come – Sunny, Breezy, and Steamy?

Drop: They will be here in a minute.

King: Drop, my old friend, as the manager of the kingdom's hydroelectric plants, you have helped me more than any other advisor to provide the people of Purestan with energy in a clean environment.

Drop: Well, Sire, as you know, I, for one, will work a hydro dam site harder to turn out abundant and clean energy. My 2,000 hydro sites provide almost ten percent of our electricity, while my lakes offer great habitats for wildlife.

King: I know, you and all the Dwarfuels have done a great job providing us with clean energy. At least up until now. But we are facing a new and serious energy and environmental problem.

Drop: What is it, Sire?

King: As you know, it has been 16 years, since Snow White's mother, Fly Ash Grey, ran off with Ole King Coal.

Drop: Yes, her love of the fossil fuels was scandalous.

King: But since she has gone we have committed ourselves to having a clean energy policy so that our daughter Snow White could always enjoy energy in a clean environment.

Drop: And your support of Woody Dwarfuel's Biomass research program is helping us look for new energy alternatives.

King: Well, Woody is the problem. Look here at Snow White's monthly cleaning bills. Each month it costs more and more to keep her clothes clean.

Drop: What are you saying?

King: Don't be a drip, Drop, I'm saying her clothes are getting dirtier each month.

Drop: Well, I have noticed some increased soot from all the wood burning stoves that are now so popular in Purestan.

King: Exactly. It is Purestan's abundant and renewable wood fuel that is polluting our air!

(Snow White enters.)

Snow White: Daddy, look at my new dress. It has smudges and soot on it, and I only took a short walk through the village. Did you fire that Dwarfuel Woody yet?

Drop: Fire Woody! Sire, if you fire Woody, who will heat all the homes in the kingdom?

King: That's why I need the advice of my key Dwarfuel. Where are those other Dwarfuels?

Drop: (*Shouting.*) Sunny! Breezy! Steamy! Get in here!

Sunny/Breezy: (*Climbing in window.*)

King: You guys must help me. I don't want to fire Woody!

Sunny/Breezy: Fire Woody!!??

King: How many times have I told you to use the door.

Sunny/Breezy: Sorry, just a habit. What's this about Woody? What did he do? Form a splinter group?

Drop: This is no joke. Snow White can't stay clean because of Woody's soot problem and he is about to be fired.

Sunny/Breezy: Fire Woody? If you fire Woody who will heat the homes?

King: That's why I called you here. If we can find an alternative way to heat the kingdom's homes, Woody can stay.

Drop: Sunny, I know you can help heat the homes because the biomass energy in Woody's forests, and Wasteful's garbage, and Corny's agricultural fields and wastes all come from you.

Sunny: And don't forget the fossil fuels.

(King fumes and Drop pulls Sunny aside to avoid the King's anger.)

Sunny: Well, I'd like to help but I can't just now. I have been so busy helping Woody, Corny, and Wasteful, the Biomass Dwarfuels, that it will take me years to design and build the passive solar collectors we would need to heat homes.

Breezy: Don't look at me, almost 90 percent of my windmills are in the western province of California. They only operate 20 percent of the time, and not much during the winter.

(Off Stage.) "SSSSSSSHHHHHHHH!!!!"

Breezy: (*To Drop.*) Don't sssshh me!

Drop: I didn't sssshhh you!

Sunny: It's Steamy. Come in, Steamy.

Steamy: Thanksss, SSSunny. SSSnow White told me about the problem and I think I can asssist.

All: How?

Steamy: In sssome localssss, like the wessssstern United SSSStatessss, only 0.1 percent of the energy comessss from Geothermal. But here in Puressssstan, we have enough heat energy underground in our hot sssspringssss regionssss to heat all the homessss in our kingdom.

Breezy: Now there is a project where I can help, because pumping water – hot or cold – is what I do best.

Snow White: Well, now that you have Woody's problem taken care of, when are you guys going to let me drive an automobile. I'm the only princess in all the kingdoms who does not own a car – it's embarrassing.

Drop: Snow White, you know your father does not want anything connected with the fossil fuels in Purestan.

Snow White: OK. What about an electric car?

Breezy: I don't make enough electricity. Besides, I'll soon be pumping water for Steamy to heat homes.

Steamy: And my hot water supply issssn't large enough to make electricity for lots of other demands.

Snow White: Sunny, what about your photovoltaic cells? They make electricity.

Sunny: They make only small amounts of electricity – just enough to power experimental cars right now.

(All turn to Drop.)

Drop: Don't look at me. My hydro is needed to supply all the other electrical needs of Purestanians – I'm tapped out.

Snow White: You guys are no help. Where is Woody? I was talking to him last week and he said he knew a way for the biomass fuels to ...

King: Enough of this! Snow White, would you please excuse us, we have work to do.

Snow White: Well, excuuuuuse mmmeee!!!

King: And send Woody and the Biomass advisors in here. I want to get to the bottom of all of this. (*Snow White leaves to get Woody.*)

Drop: First Woody is the problem, now he has the solutions.

King: I will not have dirty wood-burning cars polluting Purestan's air.

Drop: Woody must have been sipping alcohol from Corny's ethanol experiments, we all know that the biomass Dwarfuels can produce heat and some electricity.

Sunny: Yeah – but energy to power cars?

(They all laugh.)

Breezy: Wait. Do you think that they may have found a way to use Biomass to fuel cars?

All: Naaahhh!!!

(Woody, Corny and Wasteful enter with Snow White.)

King: Woody, you are my oldest energy advisor. You have made it possible for Purestanians to heat their homes with wood for centuries, but it's time ... (*Woody interrupts.*)

Woody: You're right and it's time we modernized, Your Highness, and it's time I retired. Haven't you noticed my soot's effect on Snow White's clothes?

All: What??

Woody: Yes. Corny and I have been working secretly with Snow White on this wood-burning soot problem.

Corny: And I have been working on an idea that could allow Snow White to have her automobile.

Drop: Biomass fueling cars , how?

Woody: Simple. Instead of burning our biomass, what we should do is convert our abundant corn, agriculture and wood wastes into ethanol. Ethanol is a clean burning fuel for cars that will help keep Purestan's air clean.

Corny: Our problem was, if Woody retires, how will the homes in Purestan be heated?

Woody: Here is our plan. First, Steamy, Breezy, you know all those hot springs on the other side of the kingdom?

King: Woody, my old friend, it looks like you and the other Dwarfuels have once again found a solution to our energy problems. We can start work first thing in the morning. This important work on our new energy future can wait one more sunrise.

(All exit.)

ENERGILOCKS AND CLOSE ENCOUNTERS OF THE THIRD KIND

Energilocks: My name is Energilocks and there is an energy problem in Storyland. It is my job to make sure that all the characters in Storyland are energy savers. I have a three o'clock appointment at the three bears' house to do an energy survey of their new house. I walked over to the bus stop, and being a frequent user of public transportation as a means of saving energy, I was not surprised to see three other people waiting for the bus that would take me the three miles to the three bears' house.

(Three people at the bus stop recognized Energilocks – all shout about their energy problems at once.)

All Three: Aren't you Energilocks? I've got an energy problem. You've got to help me, me first, no, me first, I was here first.

Energilocks: Wait a minute, who are you people? I can't deal with all of you at once. One at a time! You, now what's your problem?

First Man: I'm the caretaker of Sleeping Beauty's drafty castle. Sleeping Beauty has been asleep in her room for two years. The king is going broke. Heating that whole castle uses a lot of energy. In fact, it's the number one energy consuming job in all homes. If Prince Charming doesn't show up soon, we are going to have to run a drawbridge sale to pay the energy bills.

Energilocks: Then the solution is simple. Install thermostats in the rooms to control heat for time of day and season.

First Man: But what about Sleeping Beauty? Her room needs to be heated all the time or she will freeze.

Energilocks: Since Sleeping Beauty is asleep and the room doesn't need to be heated, give her an electric blanket and she will stay warm until the Prince comes.

First Man: Good idea, and thank you for your help.

Energilocks: Now, what's your problem?

Jack-be-Nimble: I'm Jack-be-Nimble.

Third Man: You know, like in Jack-be-Nimble, Jack-be-Quick, Jack jumped over the candle stick.

Jack-be-Nimble: When I was younger it was candles, now it's Jack-was-Nimble, Jack-gets-Cramps, Jack jumps over incandescent lamps. Now the problem is even these hot light bulbs are too much for me. Is there a more efficient light bulb that doesn't give off as much heat?

Energilocks: Your problem is over, Jack. Switch to fluorescent light bulbs. They use less energy and give off just as much light, but are cool to the touch.

Jack-be-Nimble: Thank you Energilocks, you sure know your energy. Here is my friend Simple Simon. Can you help him? He needs advice about energy savings on the road.

Simple Simon: Yeah, I was on the way to the fair, and after I met the pieman, I met a used car salesman. He wants to sell me a mint 1973 Dodge Charger. He says it will save me money. It's so much cheaper than a new car.

Energilocks: He is trying to con you. In the last 17 years, gas mileage on new cars has increased from 16 to 23 miles per gallon because cars are now lighter and smaller than those in 1973. If you buy a new car, you would save money and energy each time you drive it and you will pollute less, too.

All three: (*Walking off.*) Energilocks, the three of us thank you for your energy advice.

Energilocks: You're welcome. Oh dear, what time is it? It's 3:33. I was to be at the three bears' house at three o'clock. I hope they waited. (*Runs off.*)

(Three bears in car.)

Momma Bear: What's the matter, Papa? We are BEARly moving.

Pappa Bear: The car just stalled. Oh, I can't BEAR being late for our energy survey appointment with Energilocks.

Baby Bear: Do you think it has any BEARing on the old gas or air filter I told you to change last week?

Momma Bear: It's emBEARassing to break down like this, especially when all you need is a tune up.

Baby Bear: Last week Energilocks came to our school. She was there to BEAR witness to the fact that clean oil and air filters save energy and checking your tire pressure every two weeks helps save gasoline.

Momma Bear: Now our porridge is going to get cold and be BEARly edible.

(At the Bears' house.)

Energilocks: Darn. I missed them. What's this, a note?

(*Reading.*) Took Baby Bear and went to pick up Momma Bear who car pools to work with the Three Blind Mice. If we are late, BEAR with us and please wait inside. The door is unlocked, Papa Bear.

(Pounding at door.)

Energilocks: Who could that be? Yes?

Wolf: Open up in there, or by the hair of your chinny chin chin I'll huff and I'll puff and I'll blow your house in.

Energilocks: Who are you and who are you looking for?

Wolf: It is I, THE BIG BAD WOLF, and I am looking for the third little piggy!

Energilocks: (*Letting him in.*) Well, this is not the third little piggy's house. It's the three bears' house.

Wolf: Well, that's a relief!

Energilocks: Why do you say that?

Wolf: This house looks so strong and well insulated, not like the other little pigs' houses. I was able to blow their houses down with one huff and a puff.

Energilocks: I don't doubt it. I warned those pigs that their houses were too drafty and that they needed to install weatherstripping and caulking around their windows and doors to keep energy in and trouble out.

Wolf: Yeah. Well, last week, it was their houses. Today, it's the third little piggy's turn.

Energilocks: How many times have I told you characters you can save energy if you plan your trips carefully. Was this second trip to the forest really necessary? You could have huffed and puffed and blown all their houses down in one energy saving trip... But Nooohh!! I guess, energy conservation means nothing to you, or are you just THE BIG DUMB WOLF?

(A knock at the door.)

Energilocks and Wolf: Come in.

Ruba-Dub-Dub: We were told Energilocks was here. Oh hi, Energilocks. Are we interrupting?

Wolf: Yes, I'm the BIG BAD WOLF. Who are you?

Ruba-Dub-Dub: How do you do, my name is Ruba, this is my brother Dub and this is my other brother Dub.

Energilocks: How can I help you boys?

Wolf: (*Annoyed and at the door.*) Is that your car double parked out there?

Dub and Dub: Yeah, We...

Wolf: Well, you left your car running?

Dub and Dub: Yeah, well, we just have a quick question to ask Energilocks and then we'll be going.

Wolf: Well, Moe, Larry and Curly, or whatever your names are, don't you know we have an energy problem here in Storyland? Everyone knows you should not leave a car idling if you want to save gas. If you are going to be gone more than one minute, turn off the engine. (*To Energilocks.*) How was that? (*She nods approval*).

Dub and Dub: You're right, sorry about that. Energilocks, you know the three of us promote saving energy in our plumbing and bathroom supply business. (*To Wolf.*) Here is our card.

Wolf: (*Reading.*) THREE MEN IN A TUB!

Ruba: We were only thinking about saving the energy that is used to make hot water – that's about one-fifth of a home's energy budget. But you're right, we need to think about all of our energy use including cars.

Energilocks: Well, I must say that the three of you sure know many good ways to save on hot water, especially in homes.

Ruba-Dub-Dub: Well, THREE MEN IN A TUB isn't for everyone, so we give everyone we meet advice on how to save wasted energy. Like avoid taking long hot showers and use cold water whenever possible.

Energilocks: Did you guys finish that energy conservation work over at the third pig's house?

Ruba-Dub-Dub: Well, we just installed an insulating blanket around the third little piggy's hot water heater to conserve energy. In fact, his house is one of the most energy efficient houses in Storyland. He told me and my brother Dub and my other brother Dub, that we could show it to Storyland characters who want to save energy. It has plenty of insulation in the walls and attic.

Wolf: Are you telling me that his house is so well built and energy efficient that even my huffing and puffing can't blow it in?

Energilocks: Exactly, so don't even try. Come on, let's go over to the pig's house and see all the ways he saves energy.

Wolf: I'd like to, but I'm still hungry. Can't we go over after we eat something?

Energilocks: Very well, the bears did leave these bowls of porridge cooling here on the table. But this bowl of porridge is too hot.

Wolf: And this one is too cold.

Ruba-Dub-Dub: Look, the three bears have the latest energy saving appliances. We can heat the porridge up efficiently in the microwave.

Wolf: Do you think they will mind if we just have a little?

Energilocks: I don't think they will mind...do you?

INDIANA JACK AND THE PIPELINE

It's been five years since Indiana Jack's adventure with the sky giant and the magic beanstalk. Jack was living a life of leisure since he rescued the museum's goose that laid the golden eggs, and the enchanted harp and bullwhip Jack's father had brought back from a far away land. Jack regretted the death of the sky giant who stole the museum treasures, but he had warned the sky giant that after he cut down the beanstalk that first step was going to be a beaut!

For a while the region was energy rich. The biomass energy in the giant fallen beanstalk was used as fuel for their power plant. The supply seemed endless – they burned it like there was no tomorrow, but soon there wasn't much beanstalk left and an energy crisis was upon them. The power plant owner needed more fuel, and he sought out the one man who could solve this energy crisis – Indiana Jack.

(As the scene opens, Indiana Jack is having tea with his mother. Sister Mindy Anna is playing the enchanted harp that was the museum's gift for retrieving the goose that laid the golden eggs. A knock at the door – power plant owner enters.)

Power plant owner: Indiana Jack?

Jack: Yes.

Power plant owner: I heard stories about you, how you defeated the sky giant and rescued the museum treasures, but now we have a more serious problem – an energy crisis.

Jack: Energy? I don't know anything about energy. I'm just a simple archeologist adventurer – what can I do?

Power plant owner: Leave the energy stuff to me, look, we are almost out of beanstalk biomass, but I can convert the power plant to burn natural gas real easily.

Mrs. Jones: But natural gas in non-renewable.

Power plant owner: That's o.k., Mrs. Jones, but you see, natural gas is the cleanest burning fossil fuel and that's good for the environment.

Jack: O.K., but what does all this have to do with me?

Power plant owner: You are the only one who can cross the border into Methania and convince their leaders to...

Jack: Methania! What are you? Nuts? Methania is controlled by a selfish tribe of energy wasting giants... and you want me to go... (*To his mother.*) Surely, he must be kidding.

Mrs. Jones: I don't think he is kidding and how many times have I told you not to call me Shirley. It's mother to you.

Jack: Sorry, mother.

Mindy Anna: Natural gas? I just heard on TV that half the homes in the United States heat with natural gas. Why can't we use it?

Jack: Because the Methaniacs refuse to supply natural gas to anyone. It would be easier to build a pipeline from the U.S. than to try to convince the selfish Methaniacs to supply us with natural gas.

Power plant owner: But, Jack, without natural gas for our electric plant we will be having blackouts soon. You've got to help us. It's probably an impossible task, Jack, but surely you are the only one who could help us.

Mrs. Jones: Oh, no. I think Jack is more qualified for this job.

Power plant owner: Yeah, ah... think it over, Jack and let me know.

Mrs. Jones: Mindy Anna, go get your brother's summer backpack. It can get pretty hot in Methania this time of year.

Mindy Anna: But Jack didn't say he'd do it.

Mrs. Jones: Didn't the man say it might be impossible?

Mindy Anna: Yes.

Mrs. Jones: That's all your brother needed to hear.

Mindy Anna: O.K., I'll get his things.

Mrs. Jones: Jack, you'll be needing this too.

Jack: Dad's bullwhip, surely you must want to keep this.

Mrs. Jones: No, you take it and I told you not to call me Shirley. And here, take your father's enchanted harp. I have a feeling you'll need it.

Jack: But, Mom.

Mrs. Jones: Now, don't you worry. Mindy Anna will take up the clarinet.

Mindy Anna: Here is your backpack, Jack, good luck.

127

(So Jack sets off for Methania. Jack moves all around the set as if searching, climbing, struggling through an adventure. He suddenly turns and bumps into his sister Mindy Anna.)

Mindy Anna: Jack, haven't you left yet?

Jack: Yeah. I, ah...ah... just came back for my...hat.

Mindy Anna: You are wearing your hat.

Jack: O.K., O.K., then I'm off... eh, where's the door?

(She points. Jack goes out the door and immediately bumps into a fellow traveler).

Mur Captan: You're Indiana Jack. You killed the sky giant, didn't you?

Jack: You look familiar, who are you?

Mur Captan: I'm Mur (Murray) Captan. I was an energy consultant in Methania.

Jack: Methania? Then what are you doing here now?

Mur Captan: Well, I left those Methaniacs because they didn't appreciate my inventions.

Jack: Like what?

Mur Captan: Smell these beans.

Jack: Phew! They smell like rotten eggs.

Mur Captan: Right! You see, natural gas is naturally odorless and colorless, so I invented that smell to mix with natural gas. That way, if there is a leak people will smell this stuff and it will be safer using natural gas.

Jack: Beans... wait a minute, I know you... you're the guy who gave me the magic beans that grew the beanstalk?

Mur Captan: That's me, and judging from the legend of Indiana Jack they worked pretty well. And now you are holding my greatest invention.

Jack: What? Beans that smell terrible?

Mur Captan: You'll see, just take these three beans home and plant them.

Jack: I did that once and look where it got me – besides, the sky giant isn't up there anymore.

Mur Captan: These beans don't grow into beanstalks, they grow roots – hollow roots – these roots are attracted to the gas methane which makes up 90 percent of natural gas. They will grow toward and eventually tap into Methania's gas wells. When the pipeline roots are fully grown they will let you use natural gas for about 50 years, maybe more if the price goes up.

Jack: Why would you give me such valuable beans? What's in it for you?

Mur Captan: All I want is my enchanted harp.

Jack: Your enchanted harp?

Mur Captan: Yes, I gave it to your father years ago in a far off land for safe keeping. What do you say? Is it a deal?

Jack: Surely you must be joking?

Mur Captan: No. I'm not joking and don't call me Shirley, that's your mother's name. Do you believe me now?

Jack: Yes, only my father could have told you that my mother's name was Shirley.

(They exchange their wondrous gifts, and Mur Captan begins to walk off.)

Jack: Wait... why three beans?

Mur Captan: The first will grow a natural gas pipeline to heat homes. The second will grow pipelines to supply industry which is the largest consumer of natural gas, and the third one, use once you learn how to compress natural gas. It will grow pipelines to fuel cars, trucks, and buses.

Jack: But... where did he go?

(Jack's mother enters.)

Mrs. Jones: Jack, haven't you left yet, where's the harp, and who was that stranger?

Jack: Mom, guess what.

Mrs. Jones: What?

Jack: Come on, guess!

Mrs. Jones: O.K., let's see, you met someone on the road, then he traded you three beans for the enchanted harp.

Jack: How did you know?

Mrs. Jones: Oh, no. Mindy... Mindy Anna Jones, get me some aspirin, quick. Jack's done it again!!! (*She exits.*)

Jack: Anybody here have a shovel? (*Curtain.*)

CHICKEN LITTLE AND THE SKY IS WARMING

The scene is Old MacDonald's farm now run by his son Ronald. He is talking to Farmer Brown and Farmer Grey who want to buy his prized egg producing hen, Chicken Little. Chicken Little, you'll remember, was the same hen that was sent to Fanny Farmer's funny farm to rest up after the infamous "the sky is falling" panic she started on Old MacDonald's farm a while back.

Farmer Brown: So, where is Chicken Little?

Farmer Grey: Yeah, we'd like to see the merchandise before we buy.

Ron: She won't come out of the barn...she's embarrassed.

Farmer Brown: Oh, there is no need for Chicken Little to be embarrassed. So she went off the deep end last year, running all around the barnyard screaming "the sky is falling."

Farmer Grey: She shouldn't be so sensitive. We know she is only a hen – she can't expect to be as smart as Farmer Brown and me.

Farmer Brown: Besides, who remembers that stupid day anyway?

(Barnyard animals walking through.)

Animal One: Why did Chicken Little cross the road?

Animal Two: I don't know.

Animal One: To tell us that the sky was falling.

(Both laugh heartily.)

Farmer Grey: You know what I think? I think that the other animals are just jealous of Chicken Little. Yeah, jealous over Chicken Little's blue ribbon at the state fair for the most eggs laid in one day.

Ron: Are you two sure you want to buy Chicken Little? I can't guarantee she is fully recovered.

Farmer Grey: Yeah, we want Chicken Little real bad.

Farmer Brown: Well, I'm sure that from now on when Chicken Little is frightened about something in the future, she will get her facts straight first, before running around like a chicken with its head cut off. Right, Farmer Grey?

Farmer Grey: Right.

Ron: Chicken with its head cut off, yeah, very funny.

Chicken Little: (*Runs across stage shouting.*) The sky is warming – the sky is warming – the sky is warming.

Farmer Grey & Farmer Brown: What was that?

Ron: What was what?

Farmer Grey & Farmer Brown: I thought I saw – (*Farmer Grey and Farmer Brown look at each other*) naahhh!

Ron: Well, if you two want Chicken Little to remain the best egg producing chicken in the country, then you must get modern. You can't keep doing things the way my dad Old MacDonald did.

Farmer Brown: You mean letting Chicken Little watch TV for instance, like you let her do?

Ron: Right, every time David Letterman laid an egg, so did Chicken Little.

Farmer Brown: But doesn't TV use a lot of electricity?

Ron: Are you kidding, one kilowatt of electricity will operate a TV for seven hours for about eight cents.

Farmer Grey: But your father paid much more for his energy. Why is your electricity so cheap?

Ron: Well, I replaced the old power plant – like the ones you two have on your farms – with a new one. It's called a cogeneration power plant. This kind of power plant not only makes electricity, but it lets me take the normally wasted heat and use it to warm the barn and for other heating purposes.

Farmer Brown: It sounds like it would be very efficient for dairy farmers like us who could use that extra heat.

Farmer Grey: Hey, our power plants are cogenerators that make electricity and smoke.

Ron: Well, you remember my power plant used to belch smoke. As a matter of fact, remember when my Barnyard Quartet used to sing about it?

Quartet: (*To the tune of "Old MacDonald Had a Farm."*)
Young MacDonald bought this farm
with an I.O.U.
Its power plant
that belches smoke
makes us say P.U.
With some black soot here
and a darkened sky there
here's a smudge, there's some smoke
everywhere ash in your eye
Young MacDonald's power plant
caused us all to choke

Ron: But since then, I, along with other power companies, have installed scrubbers to clean the smoke before it goes up the smokestack. Some technologies such as hydro, wind, nuclear, geothermal and solar energy produce no air pollution at all. You know, Farmer Grey, the world is going electric. Over one-third of all our energy is used just to make electricity in power plants.

Farmer Grey: Yeah, and I know that the demand for electricity goes up each year. Since 1973, it has gone up 50 percent, even though our population has only grown 16 percent.

Ron: Yeah, and your profits go right up the smokestack with all those carbon and sulphur dioxide greenhouse gases.

Farmer Brown: No wonder your energy costs are so low, and you don't send out as much smoke from your smokestack as that old klunker of Farmer Grey's.

Farmer Grey: My power plant? Your power plant makes so much smoke and ash that everything on my side of the road is covered with ash. That's why they call me Farmer Grey.

Farmer Brown: Oh yeah, well, why do you think they call me Farmer Brown? Because the stuff you call coal that burns in your power plant puts so much junk into the air that all my crops have turned brown.

Farmer Grey: You can't blame me because you're a lousy farmer.

Farmer Brown: Lousy farmer, why you! (*Farmer Brown & Farmer Grey are nose to nose.*)

Chicken Little: (*Runs across stage shouting.*) The sky is warming, the sky is warming, the sky is warming.

Farmer Grey & Farmer Brown: Don't tell me you didn't see and hear that.

Ron: Hear what?

Chicken Little: (*Runs across stage shouting.*) The sky is warming, the sky is warming, the sky is warming.

Farmer Grey & Farmer Brown: That (*pointing to Chicken Little*).

Chicken Little: You are both to blame. Modern power plants – no matter what fuel they burn – use technologies to prevent soot, ash and pollutants from getting into the air.

Ron: And the coal industry is making coal a cleaner burning fuel with its research programs.

Farmer Grey & Farmer Brown: We want to see more! What do you say to a tour of your cogeneration power plant?

Ron: O.K., let's go. (*They exit.*)

(*Barnyard Quartet and Chicken Little enter.*)

Chicken Little: Are they gone?

Animal One: Yes, young MacDonald took them to the power plant.

Animal Two: O.K., our plan to keep Chicken Little from being sold is working. We have Farmer Grey and Farmer Brown just where we want them. Chicken Little, your act of running around and pretending that the sky is warming is just the right touch to make them doubtful about buying you.

Chicken Little: What act? I'm not acting. The sky IS warming. Haven't you heard of the greenhouse effect? If people like Farmer Grey and Farmer Brown don't take young MacDonald's advice and stop pumping carbon dioxide and sulphur dioxide from fossil fuels into the atmosphere the climate changes on earth could lead to disasters.

Animal Three: Where did you learn all this?

Chicken Little: Well, you remember my "sky is falling" prank.

Animals: Prank?

Chicken Little: Yeah, it was just a joke that got out of hand, but if it hadn't been for the time I spent in the Fanny Farmer's funny farm library reading, I wouldn't have learned about the greenhouse effect. So, from now on – no matter who owns me – they will only hear me shouting "the sky is warming."

Animal Four: But, what can we do about such a big problem like global warming?

Chicken Little: Simple, just do whatever you can on the local level. If everyone did one small thing in their neighborhood, that could help the global problem.

Animal Four: O.K., then let's go all out to get Farmer Grey and Farmer Brown to change their air polluting power plant technology to one that reduces the smoke coming out of their smokestacks.

Chicken Little: And if that means I must be sold to Farmer Grey and Farmer Brown then I am willing to do that.

Animal One: Well, if they buy you, and you keep running around shouting, "The sky is warming, the sky is warming," they will either buy a new power plant or have you for Sunday dinner. (*They hide as Ron enters with Farmer Grey and Farmer Brown.*)

Farmer Grey: Well, Ron, you convinced us. We are both going to buy an efficient cogeneration power plant. We should be able to save tons of money on fuel.

Farmer Brown: By the way, what fuel should we use?

Animal One: Well, you could use abundant coal – 57 percent of all electricity comes from coal and the technologies for burning it cleanly are getting better all the time.

Animal Two: You could burn oil. Petroleum is used to make five percent of our electricity.

Animal Three: Natural gas is the cleanest burning fossil fuel, and it accounts for ten percent of electrical generation.

Animal Four: What if you had a waterfall on your farm? You could add to the nine percent of pollution-free electricity that is made by falling water.

Chicken Little: Of course, when farmers all over the country buy electricity from power companies, 20 percent of that power is made by nuclear energy.

Ron: Chicken Little, why are you so interested in Farmer Grey and Farmer Brown's decision about their power plant?

Chicken Little: Because besides energy efficiency, energy decisions should consider environmental issues like the greenhouse effect. Because I know for a fact that the sky is warming...the sky is warming. (*Chicken Little runs off shouting "the sky is warming."*)

Farmer Grey: Well, that sure is strange behavior for a chicken, but we still want her.

Ron: Speaking of strange behavior – I'm real curious – why the sudden interest in chickens? You guys are dairy farmers, yet I understand that you are buying up every chicken in the county.

Farmer Grey: Well, now that we are all friends who have pledged to clean up the environment....

Farmer Brown: Especially the air...

Farmer Grey: I can be honest and tell you that we wanted Chicken Little because we heard on the radio that every summer the electric company advises people that there will be a big demand for beaks. In fact they said the beak demand is greatest between 12 noon and 6 p.m. every day.

Farmer Brown: And with Chicken Little and all the eggs she can lay we could corner the beak market. All we have to do is wait for the beak demand, and when it hits each day we will make a fortune selling beaks.

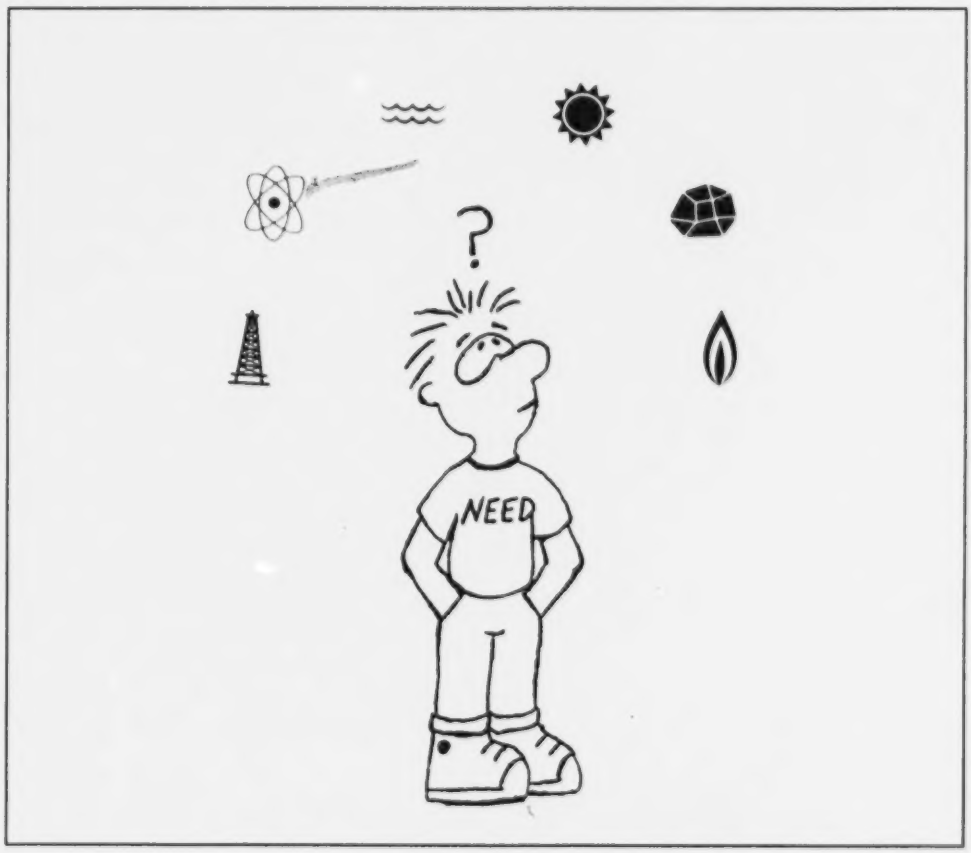
Ron: Beak Demand? Beak Demand? The power company didn't say beak demand, they said PEAK demand!! Every summer the electric company warns people that there will be a big PEAK demand for electricity. That PEAK occurs each day between 12 noon and 6 p.m., that's when most of the customers are demanding the most electricity ... PEAK not BEAK.

Farmer Brown & Farmer Grey: Oh ... never mind!

(*Farmer Grey and Farmer Brown exit, and Chicken Little, the barnyard quartet and Ron celebrate – Curtain.*)

National Energy Education Development Project

Energy Enigma



ENERGY ENIGMA

Energy Enigma is an excellent way to introduce or review information about the nation's ten leading sources of energy. The game can take as little as one hour to play, or as much as several class periods. Energy Enigma can be played with as few as 20 students or as many as 80. The game is appropriate for grades seven through adult.

PREPARING GAME MATERIALS

1. *Make ten copies of the Energy Enigma Ballot.*
2. *Make 25 copies of the Energy Enigma Game Sheet. Cut sheets in quarters and clip together in stacks of ten.*
3. *Make ten copies of the Non-renewable Energy Source Fact Sheet and ten copies of the Renewable Energy Source Fact Sheet.*
4. *Make ten copies of the Energy Enigma Graph Sheet.*
5. *Make 25 copies of the Energy Enigma Data Sheet, and cut them into quarters. Clip ten together in one stack, and staple together ten stacks of nine.*
6. *Make ten copies of the Clue Order Sheet. Fold and tape each sheet into an envelope.*
7. *Make two copies of each of the ten Energy Enigma Source Clue Sheets – one on white paper, the other on transparency stock. Cut each sheet (paper and transparency) into its eight clues and clip together.*
8. *Place the paper copies of the Energy Enigma Clues in separate envelopes, and write the team number and name of the energy source in the space provided. Keep the transparency clues for later use.*
9. *Place on each table one Energy Graph Sheet, one Data Sheet (from the stack of ten), one Non-renewable and one Renewable Energy Source Fact Sheet, and a Clue Envelope face down.*

PART I
DEVELOPING DATA SHEET

Today we are going to play *Energy Enigma*. Everyone knows what the word energy means, but the word enigma may be a complete mystery to you. Actually, a mystery is a good way to define enigma. It means something that is hard to understand or explain.

So, if we put together the words ENERGY and ENIGMA we get a game where teams research information, or clues, which will enable them to unlock the mysteries behind ten of the nation's top suppliers of energy.

Energy Enigma will also help each of you to unlock the mysteries behind working together in groups. You will be asked to communicate with others, problem solve, and utilize your academic and critical thinking skills.

Each team will be assigned an energy source. To find out what energy source your team is, just pick up your clue envelope. Your team's goal is to be the best at eliminating energy enigmas. You will do this by identifying what energy source the other teams represent, hopefully using as few clues as possible. Naturally, it's best if the other team(s) don't guess what source you are, or do take a lot of clues guessing who you are, thus giving them a lower score.

1. The first thing you must do to become the best team of Energy Enigma Eliminators is to learn something about your source of energy. To accomplish this objective, each of you has been given two Energy Source Fact Sheets – one on renewable sources, and one on non-renewable sources. Each table also has an Energy Enigma Data Sheet. Someone from the team should write the name of your energy source in the space at the top of the Data Sheet. When the Data Sheet is completed it will be for your team's eyes only, no other team should see it.
2. To successfully complete the data sheet you'll need to run an efficient team. This means each team will need a facilitator and a recorder. A facilitator keeps the session orderly and your team moving smoothly. The facilitator calls on people with their hands raised to prevent everyone from yelling out their facts all at once. He or she will point to members of the group, keeping pace with the writing speed of the recorder.

   The recorder writes down the information on the data sheet for the team. I will now give you a minute to select your team's facilitator and recorder.
3. The first question on the data sheet will be easy to answer. Just look at the Non-renewable and Renewable Energy Source Fact Sheets to determine which one your source appears on. Mark on the data sheet whether your source is renewable or non-renewable.
4. You'll get your data for questions two and three by looking at the Energy Enigma Graphs on your table. Question two asks how much energy your source of energy contributed to total energy demand. Please read the Energy Consumption Graph (top graph) and place an X in one of the five boxes.

   Do the same thing for question three using the Electrical Energy Production Graph (bottom graph) to determine how much your source contributed to the production of electricity. I'll give you a minute and a half to answer questions two and three.
5. For questions four through seven you will have to consult your Energy Enigma Source Fact Sheet.

   Your team will learn from the fact sheet if your energy source's major use is for heating, transportation, or generating electricity.

   You'll also find out if your source of energy is found everywhere in the country, or perhaps more so in certain regions of the nation. Maybe the demand for your source of energy is higher than can be supplied by domestic production, and therefore some must be imported from another country.

   For question seven, the Energy Enigma Source Fact Sheet will let you know about any facts that are particular to your source of energy. Such as when and where it was first used, or some of the environmental and economic benefits and drawbacks.

PART II
DETERMINING THE SEQUENCE OF CLUES

1. Now, each team should take out the eight clues from their Energy Enigma Clue Envelope and arrange them in one column A through H. Place your completed Energy Enigma Data Sheet next to this column.

   Starting with clue A, the facilitator should call upon members of the group to comment on the clue, i.e., this clue gives away too much information and why. The team **should not** make any decisions to eliminate clues at this time but rather discuss the strengths and weaknesses of each clue. You will have two minutes to discuss the strengths and weaknesses of the clues. **Remember, do not eliminate any of the clues at this time.**
2. Prior to deciding which clues you will be giving to the opposing teams, the recorder should turn over the clue envelope to reveal the letters A-H so that you may record your choices.

   The facilitator should start with clue A, and ask by a show of hands if anyone would like to eliminate this clue from the stack.

Printed on recycled paper

The recorder will write down the number of members wishing to eliminate each of the clues. The recorder and facilitator can vote, too.

A single team member can only suggest the elimination of a maximum of four of the eight clues. This means before you start polling you should give members a minute to decide which of the four clues they will want to eliminate. You will notice I said POLLING not VOTING. If you were voting, the four clues which received the most votes to be eliminated would be cast off and we would be ready to go. In polling, a group's general ideas are put down on paper, and discussion follows from that point.

If one of the eight clues receives no raised hands, this means that the clue probably gives the other teams little information about your source of energy. These clues will probably stay. If a clue receives a unanimous raising of hands, then it should be removed from your team's stack.

The facilitator should then lead a discussion on the pros and cons of keeping or eliminating each of the remaining clues. You will need to select four of the least revealing clues. These clues will be given to your opposing teams. Try to come up with the four clues through discussion and bargaining with members of the group. You will have five minutes to eliminate four of the clues.

When you've completed this task, take the four eliminated clues and put them back in the Clue Envelope.

3. Now, you must arrange the remaining four clues so the first clue is the least revealing of the four, the second clue should be a little more revealing, and so on. You may decide as a team to arrange the clues so that they confuse your opposing teams. You will have three minutes to organize the clues from least revealing to most revealing.

   Whatever you decide, make sure the letter on the first, least revealing clue you will be giving your opposing teams is written on the first line of your clue envelope and the fourth, most revealing clue is on the fourth line. Put these clues back in the envelope with the others to be picked up later. You will have ten minutes to make your decisions and place your clues in order. The Energy Enigma staff will pick up your Clue Envelopes in eight minutes.

PART III
DEVELOPING OPPOSING TEAMS' DATA SHEETS

Pick up Clue Envelopes and give each team a stack of nine stapled Data Sheets.

Everyone still has their Renewable and Non-renewable Source Fact Sheets and their graphs. You should use these resource materials to develop the remaining nine Energy Enigma Data Sheets. You may choose to accomplish this as one big group the same way as earlier. Your team may decide to develop the Energy Enigma Data Sheets by having smaller groups or individuals prepare them and then sharing them with the entire group toward the end of this session of the game.

Your team may decide not to share Energy Enigma Data Sheets with each other and instead have a team member, or pair of team members, serve as experts for one or more energy sources. In any case, your team must decide how to generate the data sheets and whether or not to share the information with all members of the team. Your team will have ten minutes to prepare the remaining Energy Enigma Data Sheets. Be sure to indicate in the space provided up top which energy source you are working on. At the end of this ten minute session, I will remove all the Energy Enigma Source Fact Sheets and graphs from your table. You now have ten minutes. I will give you time checks along the way.

Pick up Renewable and Non-renewable Energy Source Fact Sheets and graphs. Give each team an Energy Enigma Ballot and a stack of ten Game Sheets.

PART IV
SELECTING A TEAM'S ENERGY SOURCE IDENTITY

Now it is time for the evaluation portion of this game. You have completed the activities and the preparation to achieve your objectives. If these objectives were completed successfully, you may reach your goal of being the best team of Energy Enigma Eliminators.

During your preparation session, I have placed ten Energy Enigma Game Sheets and an Energy Enigma Ballot on your table.

Shortly, we will project the first clue of each of the ten teams on the screen. The first column of five clues will be for teams one through five, and the second row of clues for teams six through ten.

Two or more members of your team should write the information for each clue in the top box (marked clue one) of the appropriate game sheet.

Your team will then have six minutes to decide if you wish to guess which energy source is represented by an opposing team. This is done by writing the number of the team in the box next to the energy source you think they represent on your Energy Enigma Ballot for round one. For example, if you think team three is Hydroelectric you would put a three in the box marked Hydroelectric.

Your team receives 30 points for guessing correctly during the first round, 25 points for the second round, 15 points for the third, and 10 points for the fourth round. If you guess correctly, I'll circle your choice, and I will put the number of points you won in the box at the top of the ballot. If you guess wrong, I'll put an X through your choice. At the end of the game, I'll deduct 10 points for every X or incorrect guess the team has made.

Before I turn on the overhead projector and reveal the clues, I will give the teams 90 seconds to devise a plan on how they will watch the Energy Enigma Game Sheets. These game sheets are yours, so you can write any notes you want on them or turn them over if they've already been identified.

Time is up. I trust each team has agreed on a game playing strategy. Here are the first clues for round one; write them in the top box (marked clue one) on your game sheets. You will have six minutes to make a guess for any or all of the ten sources. Remember, incorrect guesses will cost your team ten points, so it may be better to leave most of them blank for the first round or two. At the end of the six minutes no ballots will be accepted.

The first round is over. We will follow the same procedure as before, and you will have six minutes again to fill any boxes on your Energy Enigma Ballot for Round two. **If you have already made a correct choice, there is no need to mark your choice in subsequent rounds.**

Continue giving the same instructions and following the same scoring procedures for the remaining rounds. For rounds three and four allow only four minutes. After the fourth round, have teams computate their scores – check their math. Announce winners and give Energy Bucks or prizes.

It appears that all of you have learned a lot about energy, and I trust a lot about what it takes to work successfully in a group. We still have _____ minutes before the end of this session. Can anyone from the audience tell me what type of questions you might ask about an unknown energy source? I will write them down on this piece of paper. (*Follow with discussion.*)

Very good! Now we can develop a list of things that are important if groups are to work together successfully. (*Follow with discussion.*)

ENERGY ENIGMA
NON-RENEWABLE ENERGY SOURCES

Petroleum

Petroleum (also known as crude oil) is a fossil fuel that took millions of years to form. When tiny sea plants and animals died, they sank to the bottom of the ocean where they were buried by layers of sand and silt. Over time, this organic matter was subject to enormous pressure and heat causing it to change into petroleum saturated rock.

Since World War II, petroleum has replaced coal as the nation's leading source of energy. The four biggest uses of petroleum in 1989 were transportation – 63 percent; industry – 25 percent; home and business – eight percent; and electric utilities – four percent.

U.S. production of petroleum is not enough to meet the nation's demand of over 17 million barrels a day. In 1989, 46 percent of the nation's supply of petroleum was imported, mostly from Saudi Arabia, Canada, Nigeria, Venezuela and Mexico. Currently, Texas is the nation's leading producer of petroleum, followed by Alaska, Louisiana, California and Oklahoma.

Coal

Coal is a fossil fuel created from the remains of plants that lived and died 100 to 400 million years ago. The dead plant matter fell into swampy water, partially decaying. Under heat and pressure this plant matter was gradually changed into carbon-rich coal deposits.

The U.S. is the world leader in known coal reserves. At current consumption rates, the United States has about 300 years of supply. Almost ten percent of the coal mined in the nation is exported to other countries. The top five coal producing states are Wyoming, Kentucky, West Virginia, Pennsylvania and Illinois.

The major method for transporting coal is by train. Over 85 percent of the coal is used by electric utility companies, the rest is used by industry. Only a very small portion is used for heating buildings and homes. A major effort is made to remove the sulfur found in coal before it is burned, or the sulfur dioxide gas formed after it is burned.

Natural Gas

Natural Gas, the cleanest burning of the fossil fuels, was formed millions of years ago when plants and tiny marine organisms died and were buried by sand and rock. Methane, a colorless and odorless gas, makes up about 90 percent of the gas extracted from a gas well. The methane is separated from the other gases and is transported by pipeline to customers. Approximately half the nation's homes use natural gas for heating, however, the major consumer of natural gas is industry.

Residential customers of natural gas are charged by the number of "therms" they use. A "therm" is a measure of heat that is equal to 100,000 British Thermal Units or BTus. Each therm costs the consumer about 53 cents.

More than 95 percent of the natural gas consumed in the nation is domestically produced. Most natural gas production comes from Texas, Louisiana, Oklahoma and New Mexico. The remaining five percent comes from Canada via pipeline.

Uranium

Uranium is the heaviest of the 92 naturally-occurring elements and was formed when the earth was created. Uranium is found in rocks all over the world, but in some areas, such as New Mexico and Wyoming, it is found in higher concentrations. The United States imported about half of its uranium in 1989. These imports resulted from cheaper prices abroad rather than limited domestic supply.

Once mined and processed, uranium is used to generate electricity. The atoms fission, or split, releasing heat energy that is used to change water into steam. The steam turns a turbine/generator. The first uranium fueled power plant was put into operation in 1957. Today, 109 plants are generating electricity.

Like most industries, nuclear power plants produce waste. The main concern is not the amount of waste but its radioactivity. The U.S. Congress has designated Yucca Mountain, Nevada, as the site to bury the waste starting in the year 2003. While nuclear power produces waste, it does not contribute to air pollution.

Propane

Propane is a by-product of natural gas and petroleum processing. About two-thirds of the propane used in the United States comes from processing natural gas. The other one-third comes from the refining of petroleum. About 15 percent of the propane consumed in the nation is imported.

Propane is a colorless and odorless gas that can be changed into a liquid by putting it under a moderate amount of pressure, or cooling it to -43.8 degrees Fahrenheit. When liquified, it is an easily portable and clean source of heat energy. Liquid propane is sold by the gallon.

The largest market for propane is in rural and suburban areas not served by the natural gas pipelines. Propane is used for heating homes, hot water and cooking. Because it is so portable, it can be used in hot air balloons and recreational vehicles. Currently, about six percent of propane is used for transportation. Propane-fueled engines emit cleaner exhaust than gasoline engines.

ENERGY ENIGMA
RENEWABLE ENERGY SOURCES

Biomass

Biomass is a fuel made from plant material. During the process called photosynthesis, plants use the sun's energy to combine carbon dioxide and water into carbohydrates. These carbohydrates can be burned to release energy. Almost 90 percent of all biomass energy comes from burning wood.

Approximately seven percent of biomass energy comes from burning garbage and agricultural waste. The energy released from burning this waste is used to generate electricity. Although burning biomass produces air pollution, sophisticated systems reduce the level of air pollution significantly.

Another method of using biomass is to change it into ethyl alcohol, or ethanol, through a process called fermentation. Corn is usually the source of biomass, and when mixed with yeast, produces a fuel which can be mixed with gasoline to make gasohol. In 1989 eight percent of the nation's motor fuels were a blend of gasoline and ethanol.

Hydropower

Hydropower is a result of the continuous water cycle of evaporation, condensation and precipitation. Gravity causes water to flow from higher to lower ground creating a force that can be used to turn turbine/generators and produce electricity.

The first hydroelectric power plant was built in 1895 at Niagara Falls in New York. Currently there are 2000 dams in the United States producing as much electricity as 80 large nuclear power plants.

Hydropower is the cheapest way to generate electricity today. While the hydropower facility is expensive to build, its energy source is free and does not contribute to air pollution. However, hydropower does make changes in the local environment because of the reservoir formed by the dam. This can disrupt wildlife in the area that is flooded.

Geothermal

Geothermal energy comes from heat within the earth. The heat, produced from the radioactive decay of elements deep below the earth's surface, is absorbed by rocks. When water comes in contact with these heated rocks, it absorbs the energy and is changed to steam. The steam can be used directly to heat buildings or to generate electricity.

The major use of geothermal is the generating of electricity, with most geothermal electric power plants being found in western states. While the source of geothermal energy is free, the cost to develop a geothermal field is expensive. The pipes and equipment must be maintained carefully because of the corrosive nature of the steam.

Wind

Wind energy is created by the uneven heating of the earth's surface by the sun. Hot air expands and rises, the heavier cooler air rushes in to take its place, creating wind. Prior to 1935, windmills were used primarily to grind grain and pump water. Today, wind turbines are used primarily to generate electricity.

Most wind turbines are located on huge wind farms covering hundreds of acres. More than 95 percent of the nation's wind machines are found in California. In fact, California is home to 80 percent of the world's wind machines.

Since the wind doesn't blow constantly, the capacity (the amount of time the wind machine is actually working) is about 25 percent. In fact, most wind energy (80 percent) is produced during the months of April through October.

Solar

Solar energy is created in the sun when hydrogen atoms are combined to form heavier atoms or helium. This process is called nuclear fusion. A small amount of mass is lost during this process and is converted into heat and radiant energy. The energy, however, radiates from the sun in all directions, and less than one percent reaches the earth.

Solar energy can be used to heat buildings and hot water. South-facing windows, brick walls, or collectors are used to absorb the solar energy. Water, stones and other materials are used to store the solar energy for the time of day when the sun is unavailable or too weak to use.

Solar energy is also used to make electricity. One way is by concentrating the sun's rays on pipes to heat water to very high temperatures. The hot water turns into steam and turns a turbine/generator, like other conventional power plants.

The sun's radiant energy can also be converted directly into electricity using photovoltaic cells. PV cells can commonly be seen powering a calculator or an emergency phone on a deserted road.

ENERGY ENIGMA BALLOT

TEAM NUMBER _____ ENERGY SOURCE _____

POINTS WON

[ ] Hydroelectric	[ ] Biomass
[ ] Natural Gas	[ ] Propane
[ ] Geothermal	[ ] Solar
[ ] Petroleum	[ ] Wind
[ ] Uranium	[ ] Coal

Game Leaders Use Only

Note: If you have already made a correct choice, do not mark your choice again in subsequent rounds.

Round 1 - 30 points

[ ] Hydroelectric	[ ] Biomass
[ ] Natural Gas	[ ] Propane
[ ] Geothermal	[ ] Solar
[ ] Petroleum	[ ] Wind
[ ] Uranium	[ ] Coal

Round 2 - 25 points

[ ] Hydroelectric	[ ] Biomass
[ ] Natural Gas	[ ] Propane
[ ] Geothermal	[ ] Solar
[ ] Petroleum	[ ] Wind
[ ] Uranium	[ ] Coal

Round 3 - 15 points

[ ] Hydroelectric	[ ] Biomass
[ ] Natural Gas	[ ] Propane
[ ] Geothermal	[ ] Solar
[ ] Petroleum	[ ] Wind
[ ] Uranium	[ ] Coal

Round 4 - 10 points

[ ] Hydroelectric	[ ] Biomass
[ ] Natural Gas	[ ] Propane
[ ] Geothermal	[ ] Solar
[ ] Petroleum	[ ] Wind
[ ] Uranium	[ ] Coal

187

Energy Enigma Data Sheet

Energy Source:_____

1. [ ] Renewable [ ] Non-renewable
2. Contribution to the total U.S. energy demand:
   [ ] Majority [ ] Substantial [ ] Moderate
   [ ] Small [ ] Very Small
3. Contribution to the total U.S. electrical energy demand:
   [ ] Majority [ ] Substantial [ ] Moderate
   [ ] Small [ ] Very Small
4. Major uses:_____
5. Major areas of domestic production:_____
   _____
6. Does domestic consumption require imports?
   [ ] Yes [ ] No
7. Your Facts:_____
   _____
   _____

Energy Enigma Data Sheet

Energy Source:_____

1. [ ] Renewable [ ] Non-renewable
2. Contribution to the total U.S. energy demand:
   [ ] Majority [ ] Substantial [ ] Moderate
   [ ] Small [ ] Very Small
3. Contribution to the total U.S. electrical energy demand:
   [ ] Majority [ ] Substantial [ ] Moderate
   [ ] Small [ ] Very Small
4. Major uses:_____
5. Major areas of domestic production:_____
   _____
6. Does domestic consumption require imports?
   [ ] Yes [ ] No
7. Your Facts:_____
   _____
   _____

Energy Enigma Data Sheet

Energy Source:_____

1. [ ] Renewable [ ] Non-renewable
2. Contribution to the total U.S. energy demand:
   [ ] Majority [ ] Substantial [ ] Moderate
   [ ] Small [ ] Very Small
3. Contribution to the total U.S. electrical energy demand:
   [ ] Majority [ ] Substantial [ ] Moderate
   [ ] Small [ ] Very Small
4. Major uses:_____
5. Major areas of domestic production:_____
   _____
6. Does domestic consumption require imports?
   [ ] Yes [ ] No
7. Your Facts:_____
   _____
   _____

Energy Enigma Data Sheet

Energy Source:_____

1. [ ] Renewable [ ] Non-renewable
2. Contribution to the total U.S. energy demand:
   [ ] Majority [ ] Substantial [ ] Moderate
   [ ] Small [ ] Very Small
3. Contribution to the total U.S. electrical energy demand:
   [ ] Majority [ ] Substantial [ ] Moderate
   [ ] Small [ ] Very Small
4. Major uses:_____
5. Major areas of domestic production:_____
   _____
6. Does domestic consumption require imports?
   [ ] Yes [ ] No
7. Your Facts:_____
   _____
   _____

Energy Enigma Game Sheet

Team _____

Clue 1

Clue 2

Clue 3

Clue 4

Energy Enigma Game Sheet

Team _____

Clue 1

Clue 2

Clue 3

Clue 4

Energy Enigma Game Sheet

Team _____

Clue 1

Clue 2

Clue 3

Clue 4

Energy Enigma Game Sheet

Team _____

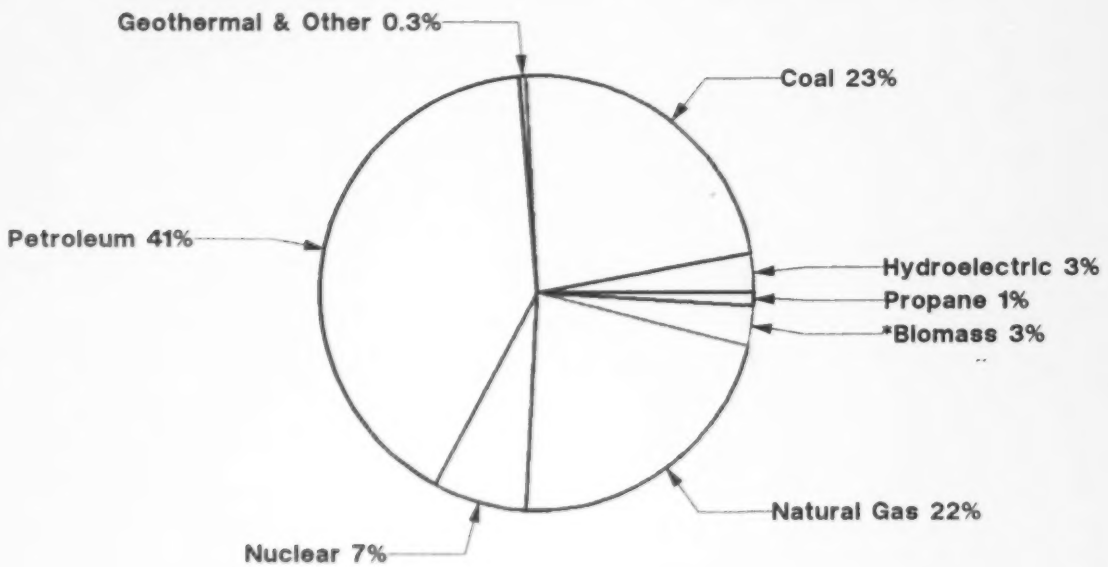
Clue 1

Clue 2

Clue 3

Clue 4

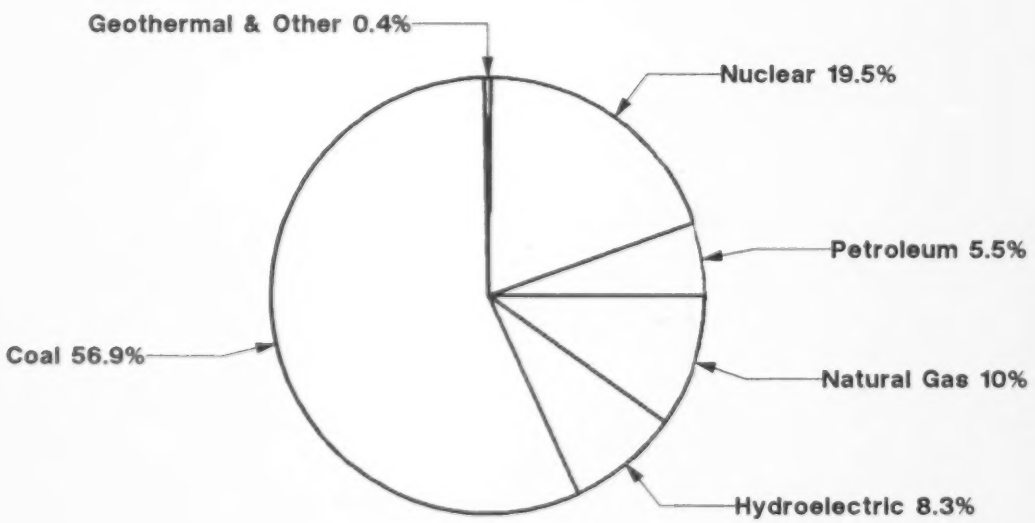
ENERGY ENIGMA GRAPH 1
CONSUMPTION OF ENERGY BY SOURCE 1989



*Estimate

Source: Energy Information Administration

ENERGY ENIGMA GRAPH 2
ELECTRIC POWER GENERATED BY SOURCE 1989



Source: Energy Information Administration

Clue Order

Letter

1. _____
2. _____
3. _____
4. _____

Team Number:	Energy Source:

Fold Here

_____ H

_____ G

_____ F

_____ E

_____ D

_____ C

_____ B

_____ A

141

Energy Enigma Source Clues

Group ___1A

It generates a majority of U.S. electricity.

Group ___1B

10% of U.S. production is exported.

Group ___1C

U.S. is the world leader of known reserves.

Group ___1D

It's a fossil fuel.

Group ___1E

It's transported mostly by train.

Group ___1F

It supplies the U.S. with about a quarter of its energy needs.

Group ___1G

Major efforts are taken to reduce its sulfur emissions.

Group ___1H

Appalachian states are major producers.

Team 1 Coal

Energy Enigma Source Clues

Group ___2A

Generates a moderate amount of U.S. electricity.

Group ___2B

It's a fossil fuel.

Group ___2C

It's non-renewable.

Group ___2D

Industry is its largest consumer.

Group ___2E

It's a colorless and odorless gas.

Group ___2F

It supplies the U.S. with about a quarter of its energy needs.

Group ___2G

It's a relatively clean fuel.

Group ___2H

It's measured and sold by the therm.

Team 2 Natural Gas

Energy Enigma Source Clues

Group ___3A

It generates a very small amount of U.S. electricity.

Group ___3B

It's renewable.

Group ___3C

Methane gas can be made from it.

Group ___3D

Using it can cause air pollution.

Group ___3E

It gets its energy from photosynthesis.

Group ___3F

It provided 1/25 of the nation's energy needs for 1989.

Group ___3G

Ninety percent of its energy comes from burning wood.

Group ___3H

Ethanol can be made from this source for transportation.

Team 3 Biomass

Energy Enigma Source Clues

Group ___4A

Transportation is its major use.

Group ___4B

Almost half consumed in the U.S. is imported.

Group ___4C

It's non-renewable.

Group ___4D

It generates a small portion of U.S. electricity.

Group ___4E

It's the leading supplier of U.S. energy.

Group ___4F

It's measured and sold by the barrel.

Group ___4G

Most domestic production comes from states west of the Mississippi River.

Group ___4H

Using it causes air pollution.

Team 4 Petroleum

Energy Enigma Source Clues

Group ___5A

It generates a very small amount of U.S. electricity.

Group ___5B

It's renewable.

Group ___5C

It's free to use, but you must build and maintain its equipment.

Group ___5D

It can be used to directly heat buildings.

Group ___5E

Supplied the U.S. with about 1/200 of its energy.

Group ___5F

It can not be counted on to provide energy at all hours.

Group ___5G

It gets its energy as a result of nuclear energy.

Group ___5H

Photovoltaic cells convert it into electricity.

Team 5 Solar

Energy Enigma Source Clues

Group ___6A

It generates a small amount of U.S. electricity.

Group ___6B

It's renewable.

Group ___6C

Most production comes from west of the Mississippi River.

Group ___6D

It provides the U.S. with 1/200 of its energy needs.

Group ___6E

Almost all of its energy is used to generate electricity.

Group ___6F

It gets its heat energy from the energy given off by radioactive materials.

Group ___6G

It can cause air and water pollution.

Group ___6H

It's free to use, but you must build and maintain its production equipment.

Team 6 Geothermal

Energy Enigma Source Clues

Group ___7A

It's sold by the gallon.

Group ___7B

It's non-renewable.

Group ___7C

Two-thirds of its supply comes from processing natural gas.

Group ___7D

It's a colorless and odorless gas.

Group ___7E

It's a relatively clean fuel.

Group ___7F

It provides about 1/50 of U.S. energy demand.

Group ___7G

Under moderate pressure, it can be compressed into a liquid.

Group ___7H

It's a very portable source of heat energy.

Team 7 Propane

Energy Enigma Source Clues

Group ___8A

It was first used commercially in 1957.

Group ___8B

It's non-renewable.

Group ___8C

All of its energy production is used to generate electricity.

Group ___8D

There are 109 generating locations in the U.S.

Group ___8E

Its energy is released through the splitting of atoms.

Group ___8F

Its waste product may be stored in Nevada.

Group ___8G

Using it does not produce air pollution.

Group ___8H

The U.S. is the world's leading producer of electricity by this source.

Team 8 Uranium

Energy Enigma Source Clues

Group ___9A

It generates a very small amount of U.S. electricity.

Group ___9B

It's renewable.

Group ___9C

It's free to use, but you must build and maintain its equipment.

Group ___9D

U.S. is world's leading producer of electricity by this source.

Group ___9E

Provides the U.S. with 1/1000 of its energy needs.

Group ___9F

Most of its production comes from states west of the Mississippi River.

Group ___9G

When a production facility is built, large amounts of land are required.

Group ___9H

It can not be counted on to provide energy at all hours of the day.

Team 9 Wind

Energy Enigma Source Clues

Group ___10A

It generates a moderate amount of U.S. electricity.

Group ___10B

It's renewable.

Group ___10C

It provides the U.S. with about 1/25 of its energy.

Group ___10D

There are 2,000 generating locations in the U.S.

Group ___10E

A production facility disrupts a large amount of land.

Group ___10F

It was first used to make electricity in 1895 along the New York and Canadian borders.

Group ___10G

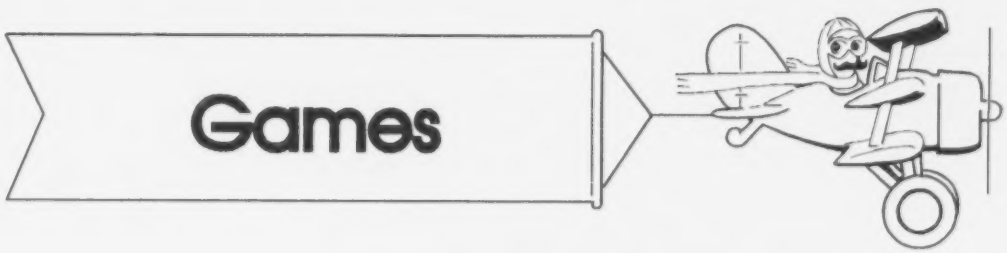
It's free to use, and expensive to build the production facility.

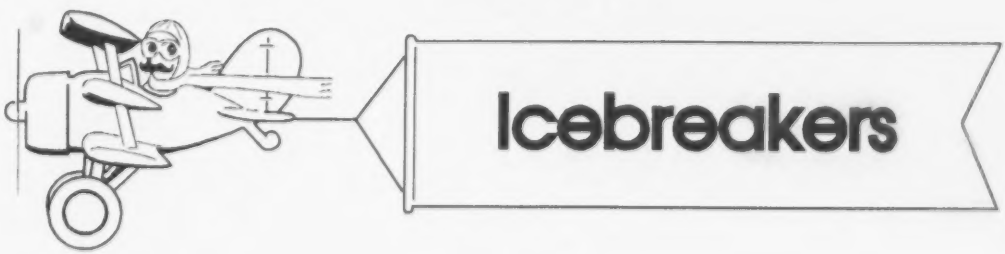
Group ___10H

Using it doesn't cause air pollution.

Team 10 Hydroelectric

National Energy Education Development Project





Energy Name Game

Purpose of Activity

Energy Name Game is a short and easy introduction to other members of a group. It requires no preparation and very little time. This activity is suited for all ages.

Preparation: None

Time: 10 minutes for a group of 12

GET READY

No preparation required.

GET SET

Have the members of the group seated in a circle facing inward.

GO

The group leader should tell everyone that they will now be getting a new second name. Their new second name should begin with the same letter as their first name and be energy related. The second name could be a source of energy, an energy consuming or producing device, or energy term. For example: Bob Biomass, Martha Microwave, Georgette Generator, or Michael Megawatt. Tell the members of the group that no relatives will be allowed in the game, so you can't have a Bob and Barbara Biomass. Therefore, everyone should think of at least two or more last names.

The group leader or a random group member begins by saying, "My name is..." and then his or her first name, followed by their new energy last name. Then the person to their left says the first person's first and last name, and then his or her new energy name. Then, the third person gives the first two names and then their own energy name. This continues until the final person, sitting to the right of the group leader, gives everyone's name and then their own.

Before you get started, ask if anyone in the group is having a problem thinking of an energy last name. For those who are having a problem ask them to tell the group their first name. Then have the group brainstorm several last names for them. If during the game someone in the group has a problem remembering a person's first or last name have members of the group give that person a hint. For example: If the person's name is Tim Toaster someone in the group could say "you put your bread in it in the morning." If the person's name is Peter Petroleum, a group member could say "you make gasoline from it."

Energy Pantomime

Purpose of Activity

Energy Pantomime is a quick and easy way to break a group into several smaller groups. It gets the audience moving, looking, thinking, and acting. It will produce a random mix of groups or a mix of groups by ages depending on how the slips are handed out. It is short and easy for your time scheduling, and fun for your audience. It requires only one staff member to run, although many can be involved. This activity is suited for all ages.

Preparation: Low

Time: 5 minutes

GET READY

To do this activity, you need to duplicate the sheet of pantomimes (ten per sheet) according to the number of people you want to have in each group. Our sheet of pantomimes is included in this booklet on page nine. Feel free to use this sheet, or to make up your own. You will need enough slips to hand out to everyone. If you have a small group, you may want to use less than ten pantomimes.

GET SET

To ready yourself, have the pantomime sheets cut into separate pantomime slips. If you want to have a random mixture of people, just hand out the slips randomly. You may wish to divide the groups by age level, or groups deter-

mined by the students' strengths and personalities. Fold over the pantomime, write the student's name on it, and distribute the slips.

GO

Explain to the audience that they are about to be broken into smaller groups. Tell them that they will be handed a slip of paper with an energy source or user on it. They must not say the name of their source or energy producing or consuming device aloud – just read it, and put it in their pocket. Hand out (or have assistants hand out) the pantomimes. Once all the slips have been handed out, tell the audience that they must now begin to pantomime the energy source or user. They may make sound effects and hand motions, but no talking, whispering, or reading lips. Once they have begun to pantomime, they must walk around the room, finding others pantomiming the same source or object, until all members of all groups have found each other. You should now have the audience neatly divided into groups.

CONSERVATION FOR OUR NATION

Purpose of Activity

This activity teaches brainstorming and cooperation skills to a group or groups of about eight to 15 people. It reinforces ideas of group sharing and cooperative education, as well as assuring knowledge of some conservation tips. It is a short activity, useful as an icebreaker in newly met groups. There is also a possibility of light competition between groups. This activity is suited for all ages.

Preparation: Low

Time: 20 minutes for a group of ten

GET READY

You will need a marker and a large sheet of paper (about poster-size) for each group. Have the group seated in a circle near a chalkboard or wall where you can hang up the paper.

GET SET

One person from each group should be selected as the facilitator, and one person from each group should be selected as the recorder.

GO

Instruct the group that they will be brainstorming ideas on energy conservation in the home and on the road. The facilitator should call on people from the group for energy conserving tips or measures. The recorder should list these tips on the paper. Each idea should be simple and no longer than four or five syllables. For example, "Turn off lights," "Tune-up," and "Insulate" are simple and short. The members of the group should all contribute to the list, and help each other out with ideas. Continue brainstorming until the group has at least the same number of ideas as there are group members. This should take about five minutes or so, depending on the size of the group.

Now tell the group that they are about to play the game. Start off explaining the game by doing this introduction: slap your thighs once with both hands and say CON, clap once and say SER, snap your right fingers and say VA, and then your left and say TION. Slap your thighs again and say FOR, clap your hands and say OUR, snap your right fingers and say NA, and snap your left and say TION. Slap your thighs a third time and say CON, clap once and say SER, snap your right fingers and say VA, and then your left and say TION. Slap your thighs a fourth time and say READY, clap your hands and say BEGIN. This time between the snaps you must give a conservation tip. Each cycle should take between three to four seconds.

The group leader should demonstrate this to the group. After giving the introduction, the leader should give three or four conservation tips between the snaps. Do not repeat the introduction with each tip. You can reinforce the cadence by giving the instructions to the group between the snaps. For example: slap, clap, snap YOU CAN ONLY snap, slap, clap, snap (sscs) GIVE A CON (sscs) SERVA (sscs) TION TIP (sscs) BETWEEN (sscs) THE SNAPS (sscs) IF YOU CAN'T (sscs) THE GROUP MUST (sscs) START OVER (sscs) AGAIN.

Tell the group to look very carefully at the sheet of paper, because it will not be posted during the game. Everybody will have to remember three to five of the conservation tips, because no one can repeat what someone else has said. If someone forgets or repeats, the circle must begin again. The person who has made the mistake begins with the introduction, and the game continues until you have made a complete circle with everyone giving a tip between the snaps.

NOTE: If you are running more than one circle at a time, instruct the group they may have to begin again on their own if someone makes a mistake.

ENERGY SOURCE RELAY RACE

Purpose of Activity:

Energy Source Relay Race tests students' ability to recognize important pictorial representations of energy sources or energy producing, consuming, or conserving devices and materials. This activity is suited for all ages.

Preparation: Low

Time: 20 minutes

GET READY

You will need six pieces of paper and two pencils for each group of approximately five students. Also, you have to determine which five energy terms to use during the game. For Elementary level students you might choose lightbulb, solar, biomass, television and petroleum. For Middle School students, coal, insulation, natural gas, wind and thermostat could be good choices. High School level terms might include propane, nuclear fission, geothermal, hydropower and photosynthesis. Students should be arranged in a circle on the floor or around a table.

GET SET

The students should be divided into groups of about five. On five of the six pieces of paper, instruct the students to write the name of their group in small print on the bottom and number the pages one through five. They should fold and tear the sixth sheet into eight equal pieces. Inform the students that there must be no talking at all during the game and they must walk to the game leader and back to their groups. If they do run, they will be asked to return and walk. If they talk, they will be automatically disqualified.

GO

One student from each group must be chosen as the opening artist. He or she will approach the game leader and receive the first energy term as soon as the starting signal is given. All artists are given the first term at the same time. The artist returns to his or her group and draws a representation of the term. Instruct them that there is to be no writing of words or letters, pointing or use of numbers. When someone in the group thinks they know the answer, they should take the second pencil and write their guess on one of the eight small pieces of paper. Remind the students that they are allowed eight guesses for five terms, so they can only afford three mistakes. The artist nods to inform whether or not the guesser is correct. If not, guessing continues. If the person is correct, they take the drawing and slip of paper with the correct term and give them to the game leader. The leader whispers or shows the next term to the student. He or she then returns to the group and play continues with that person as the new artist. It is always the person who correctly guesses the term who draws next. The leader should remember to constantly move around the room to avoid being closer to one group than another. The first group to correctly guess all five terms wins. Follow up with a discussion of the energy terms and display various drawings from the individual groups.

ENERGY CHANTS

Purpose of Activity:

Energy Chants introduce the ten leading energy sources in an entertaining manner. This activity also divides a large group into ten or fewer small groups.

Preparation: Low

Time: 30 minutes

GET READY

You need to make enough copies of the Energy Chant sheet on page ten of this guide, so that everyone will have one. Then, depending on the number of small groups you will have and the number of students in each group, make the appropriate number of copies of the energy symbols, found on page 11. Cut out the energy symbols and get the masking tape ready.

GET SET

You should hand out the Energy Chants to the students and tape an energy source to their back. Inform them that they are not to look at their back or ask a friend what energy source they are.

GO

The first step is to introduce the energy sources to the students. You should go through each source and reinforce one or two of the facts found on the chant sheet. Tell whether the source is renewable or non-renewable, and add some of your own information about each source. Usually, three or four facts are enough—the students can read the others on their own. After you introduce a source, demonstrate its chant. The words are on the top of the chant sheet and you can create your own hand motions. If you have problems with the motions you can contact either the NEED Office or your Regional or State NEED Coordinator.

A few examples of hand motions are:

Coal: While chanting, "Working in a coal mine," pretend that you are shoveling coal. At "grunt- Hard hat!" throw the coal over your shoulder.

Natural Gas: After chanting, "Nat'ral gas, gas" snap once with your right hand, then once with your left and follow with "a real gas!"

Biomass: Hold your nose while chanting, "Garbage, garbage" and during "Biomass!" shake your hands near your shoulders.

Wind: Throughout the chant, spin your arms like a windmill.

Hydro: With your finger tips touching, hold your hands under your chin and glide your hands down like a waterfall during, "Falling water." For "hydropower, hydropower" rotate your hands around each other like a turbine.

After you have demonstrated each chant, give the students a review quiz. Read off one or two easily recognizable facts and tell them to give you the corresponding chant on the count of three. This reinforces the information and reviews the chant. Do this for all ten chants. Next, inform students that on their back is an energy source and their job is to discover which source they are. Using their energy chant sheet, they should go around asking yes or no questions, asking each person no more than one question. Naturally, the first question should be, "Am I (non)renewable?" Once the student has discovered his or her source, he or she should start to do the energy chant for that source, in hopes of attracting others who are the same source. After about two minutes of questions and searching, have everyone stop. To help the students who may have not yet found their group, give three clues about one group's source and tell that group to do their chant once. Go through this process with each group, and the previously large group will be successfully divided into smaller groups by energy source.

THIS WEEK IN ENERGY CONSERVATION

Purpose of Activity:

This Week in Energy Conservation is fashioned after a weekly television show with student-correspondents reporting on a variety of energy conservation topics. This activity will introduce students to many ways of saving energy both in the home and on the road.

Preparation: Low

Time: 45 minutes

GET READY

Prior to class, you should make a copy of the five lead stories (found on page 12) that you will be distributing among the student groups. You may also want to gather the supplies students may use in constructing props to accompany their energy stories.

GET SET

You should review with students the structure of an actual news program. Explain the role of an anchorperson in providing the background information or "lead" to a news story. Also, you should ask them to recall the various ways they have seen news stories covered in the past (i.e. in-studio, on-site, through interviews, or taped recordings.) This will enable them to better understand what they will be asked to do during the "This Week in Energy Conservation" show. You should also divide the class into groups of five or six students. Distribute to each group the news lead for their segment of the show.

GO

Explain to the students that each group is now a team of energy reporters. They should read the introduction to their segment of "This Week in Energy Conservation," making note of the energy facts listed below each lead. Inform them that their job will be to develop a story that follows the guidelines of the anchorperson's introduction

and includes six of the energy facts listed on their sheet of paper. Each story should be limited to two or three minutes and the groups will be allowed twenty minutes to develop and rehearse their story. After each story is presented, the other groups will have one minute to try to list the six energy tips from the presentation they just heard. Then the presenting group reveals their tips. Each group grades themselves using the honor system, getting one point for every tip they correctly remembered. The sum of the other groups' scores is obtained, and this amount is rewarded to the presenting group. This gives the presenters an incentive to do a complete and thorough job, and to include all of their facts and information. The team with the highest score after all the presentations is the winner. Either you or a student from each group can serve as the anchorperson, providing the show's introduction and the lead-in to each news story.

ENERGY BINGO

Purpose of Activity

Energy Bingo is a great ice-breaker for a NEED workshop or conference since each person playing the game will meet at least 16 other people. As a classroom activity, it also makes a great introduction to an energy unit.

Preparation: Low

Time: 45 minutes

GET READY

Duplicate as many Energy Bingo sheets (found on page 13) as needed for each person in your group. In addition, decide now if you want to give the winner of your game a prize and what the prize will be. (NOTE: You'll notice that each box on the Energy Bingo sheet has two blank lines. One line is for a player's name and the other is for his or her class, school, or state. You decide what you want the players of your game to write in the second line.)

GET SET

Pass out one Energy Bingo sheet to each member of the group.

GO

Give the group the following instructions on how to play the game:

Energy Bingo is very similar to regular Bingo. There are just a few things you'll need to know to play this game. First, please take a minute to look at your Energy Bingo sheet and read the 16 questions at the top of the page. Shortly, you'll be going around the room trying to get 16 people to answer these questions so you can write their names in one of the 16 boxes.

When I give you the signal, you'll get up and ask a person one of the questions at the top of your Bingo sheet. If the person can give a response and you think it's a correct response, write the person's name in the corresponding box on the lower part of the page. For example, if you ask a person question "D" and he or she gives you what you think is a correct response, then go ahead and write the person's name and school/class/state in box D. A correct response is important because later on, if you get Bingo, that person will be asked to answer the question correctly in front of the group. If he or she can't answer the question correctly, then you lose Bingo. So, if somebody gives you an incorrect answer, ask somebody else! And be sure you don't use your name for one of the boxes or use the same person's name twice.

Try to fill all 16 boxes in the next 20 minutes. This will increase your chances of winning. After the 20 minutes are up, I will get you seated and start asking players to stand up and give their names. Are there any questions? You'll now have 20 minutes. Go!

During the next 20 minutes, move around the room to assist the players. (You too can be placed on a person's Bingo card if you wish. However, if you do this, make sure you call on yourself later on to give your name.) Every five minutes or so tell the players how many minutes are left remaining in the game. You'll especially want to give the players a warning when there's just a minute or two remaining. When the 20 minutes are up, stop the players and ask them to be seated. Then give them the following instructions:

When I point to you, please stand up and in a LOUD and CLEAR voice give us your name and tell us where you are from. Now, if anyone else has the name of the person I call on, put a big "X" in the box with that person's name. When you get four names in a row — across, down, or diagonally — shout "Energy Bingo!" Then I'll ask you to come up front to verify your results.

Let's start off with you (point to a player in the group). Please stand and give us your name and tell us where you're from. (Player gives name and place. Let's say the player's name was "Joe.") Okay, players, if any of you have Joe's name in one of

your boxes, go ahead and put an "X" through that box. (NOTE: You may have to repeat a player's name if others can't hear. Also, be sure to point to players in all areas of the room and not just in one section.)

When the first player shouts "Energy Bingo," ask him (or her) to come to the front of the room. Ask him to give his name and tell the group where he's from. Then ask him to tell the group how his bingo run was made, i.e., across from A to D, down from C to O, and so on.

Now you need to verify the bingo winner's results. Ask the bingo winner to call out the first person's name on his bingo run. That player then stands and the bingo winner asks him the question which he previously answered during the 20-minute session. For example, if the question was "can name two renewable sources of energy," the player must now name two sources. If he can answer the question correctly, the bingo winner calls out the next person's name on his bingo run. However, if he does not answer the question correctly, the bingo winner does not have bingo after all and must sit down with the rest of the players. You, as host of the game, then continue to point to players until another person yells "Energy Bingo."

In case of a tie, ask the bingo winners to come to the front one at a time to verify their results. If time permits, you may wish to continue the game for second and third place winners. You may want to change some of the questions to fit your group. Below are six extra questions you can use instead.

Can name two ways to increase a car's MPG.
Knows which fuel is used in barbecue grills.
Knows which state produces the most oil.
Knows which state produces the most coal.
Can name two products made from petroleum.
Knows which energy source generates the most electricity.

ENERGY ROUNDUP

Purpose of Activity

Energy Roundup is a good activity for introducing an energy unit or for reinforcing students' knowledge of the nation's leading sources of energy. Energy Roundup divides a group of teachers or students into ten or fewer groups.

Preparation: Medium

Time: 10 - 50 minutes

GET READY

You will need to make ten energy posters, each approximately one foot square. The first step in making the posters is to write down six energy facts for each energy source. These energy facts can be found on the Energy Chants sheet located on page 11. Write the facts on pieces of white paper. Do the lettering neatly, using letters that are about one-half inch in height. Do NOT write the names of the energy sources on these white sheets of paper. Next, take ten smaller pieces of paper and write the numbers one through ten on them.

Mount the white fact sheets and the number sheets on poster boards, using black poster boards for the non-renewable energy sources and yellow poster boards for the renewable energy sources. Mount the number sheets near the top of the posters and the fact sheets on the lower half of the posters. Do not yet secure the bottom edge of the number sheets on the poster; the number sheets will be used as flaps.

Now you can write the names of the energy sources on the posters. Write the names beneath the number sheet flaps. Then, lightly secure the bottom edge of the number sheets (with a tack or scotch tape, for example) to the posters.

Once you have finished making the posters, mount the posters on the walls of the room. Space the posters as equally apart as possible and set up chairs for each station. Also, put a piece of paper and a pencil by each poster station. The players will use these toward the end of the game.

GET SET

Assign players to groups by writing the names of the ten energy sources on slips of paper – let the players draw these out of a hat. You will need to make enough slips for each person and an equal amount of slips for each energy source. (You can assign players to less than ten groups by eliminating one or more energy sources from the hat. Even if you have fewer groups, keep all ten posters on the walls.) Instruct the players NOT to tell anyone what group they've picked; that would only hurt their chances of winning.

GO

Give the players these instructions for playing the game:

You have all been assigned to one of ten energy source groups. Shortly, you'll be getting into these groups. First, though, follow my instructions.

You can not speak or communicate with anyone during the first eight- to ten-minute phase of the game.

Decide if the energy source you selected from the hat is a renewable or non-renewable source of energy. The ten posters on the walls around the room have been color-coded to help you find your energy source. The yellow posters represent renewable energy sources; the black posters represent non-renewable sources. If you don't know if your energy source is renewable or non-renewable, then it may take you a little longer to find your group.

When I say go, walk to the closest poster and read the six clues that describe that energy source. If you think these clues describe your energy source, simply sit down in one of the chairs (or bring over a chair). If the clues don't describe your energy source, move on to another poster. Repeat the process until you think you've found your energy source.

You'll now have three minutes to find your energy source. Remember, no talking or communicating is allowed. Does anybody have any questions? Ready? Go!

(Time the round. The first round lasts three minutes.)

Your three minutes are up and everyone must be seated. Remember, remain silent. Now, will the person closest to each poster lift the flap of the poster so that the people in your group can see what energy source the clues describe.

(Players lift flaps to reveal energy sources.)

Please close the flap. If you're in the correct group, remain seated. If you're not, stand up and look for your energy source again. This time you have only one minute. Go!

(Time the second round. Round two lasts one minute. You can continue rounds until everyone has found his or her energy source. Subsequent rounds last one minute each.)

After all the rounds are finished, give the groups these instructions:

You will be allowed to talk during this part of the game. The members of your group must now decide which three of the six clues reveal the least about your energy source. Eliminate the three clues that reveal the most. I'll give you two minutes to do this, and then I'll ask three people in your group to stand up one at a time and read a clue. After the third clue has been read, everyone in your group will say in unison, "Who are we?"

Now, one person in your group should take the pencil and paper at your station and write the numbers one through ten down the side of the paper. After a group says "Who are we?" the other groups will have 15 seconds to write down the name of the energy source. Since every source has a number, just write the group's name by the corresponding number on your piece of paper.

The group that identifies the greatest number of energy groups wins. Spelling counts!

ELECTRIC CONNECTIONS

Purpose of Activity

Electric Connections teaches students how different energy sources contribute to the generation of electricity. This activity demonstrates the advantages of working together in a group and reinforces the ideas of group sharing and cooperative learning.

Preparation: Low

Time: 30 minutes

Get Ready

Make an appropriate number of copies of the Electric Connenctions Game Instructions sheet and the U.S. Electric Power Generation Sources sheet found on pages 14 and 15.

GET SET

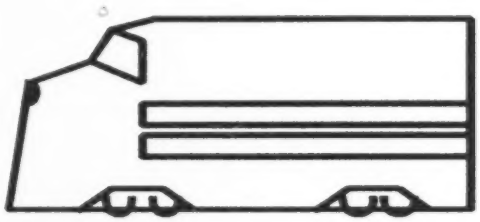
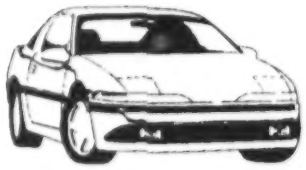
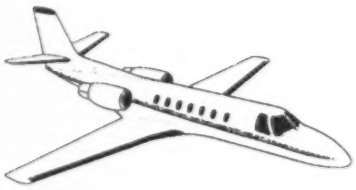
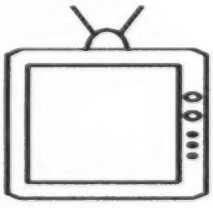
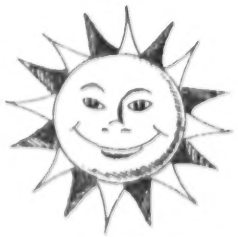
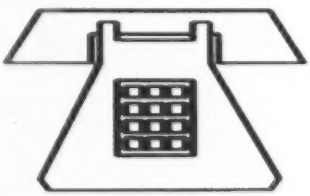
Divide the students into groups of three to five. Give each student a copy of the Game Instructions sheet. Review the game instructions with the students.

GO

Have the students individually rank the 10 sources of energy in order of their contribution to the U.S. electricity demand – give them two minutes to complete this task. As a group, give the students six minutes to rank the 10 sources of energy. When they are finished, give each student a copy of the Power Generation Source sheet.

OPTION: Before making copies of the Power Generation Source sheet, you may wish to white out the numbers under the "Ranks" column. Have the students fill in their own rankings by checking to see how many million kilowatt-hours of electric power generation each source produces.

APPENDIX

TRAIN 	AUTOMOBILE 
PLANE 	WINDMILL
TELEVISION SET 	LIGHTBULB
TREE	SUN 
TELEPHONE 	BIKE

ENERGY CHANTS

Petroleum: Blup, Blup, PETROLEUM!

Natural Gas: Nat'ral gas, gas, (snap, snap) . . . a real gas!

Coal: Working in a coal mine (grunt) – Hard hat!

Nuclear: Nuke, Nuke . . . Nuke cle – ar!

Biomass: Garbage, Garbage, Biomass!

Hydro: Falling water, hydropower, hydropower!

Propane: Compress, Compress, Compress . . . Pro – pane!

Geothermal: Shhhhhhhh, Ge – o – ther – mal!

Wind: The answer is blowin' in the wind!

Solar: Sunshine Energy, Yes, Sunshine Energy!

Non-Renewable Energy Sources

Petroleum

1. My major use is for transportation.
2. 46% of me must be imported from other countries.
3. The Soviet Union is the world's largest producer of me.
4. I'm number one in the U.S., providing 41% of America's total energy.
5. Texas, Alaska, and Oklahoma are the leading states that produce me.
6. Saudi Arabia has the world's largest known reserves of me.

Coal

1. I generate 57% of the nation's electricity.
2. I'm transported chiefly by trains.
3. My sulfur content ranges from 0.5 to 3.0%.
4. I'm America's most abundant source of energy.
5. 10% of me produced in the U.S. is exported to other countries.
6. West Virginia, Wyoming, and Kentucky are states that produce me.

Natural Gas

1. I heat over half the nation's homes.
2. I'm colorless and odorless.
3. 90% of me is methane.
4. Industry is my largest consumer in the U.S.
5. I'm the cleanest burning fossil fuel.
6. I'm transported mostly by pipeline.

Uranium

1. I'm the nation's second leading source for generating electricity.
2. I'm presently being used in 109 locations in the U.S.
3. I was first used in 1957 to make electricity.
4. I supply 5% of total U.S. energy production.
5. The U.S. leads the world in production of electricity from me.
6. Nevada may some day store my waste products.

Propane Gas

1. I'm colorless and odorless.
2. Two-third's of me comes from processing natural gas.
3. My largest use is in rural areas.
4. I supply 1% of the nation's energy.
5. I'm used by recreational vehicles.
6. I'm normally stored under pressure.

Renewable Energy Sources

Hydroelectric

1. I supply 4% of U.S. energy production.
2. I'm limited to certain geographic areas of the U.S.
3. I provide 25% of the world's electricity.
4. I'm presently being used in 2,000 locations in the U.S.
5. I may disrupt wildlife and fish when my production facility is built.
6. I require the earth's gravity to work.

Biomass

1. Methane gas can be made from me.
2. I'm 3.5% of the U.S. energy production.
3. I get my energy from wood, garbage, and agricultural waste.
4. I can be used to generate electricity.
5. Ethanol can be made from me and used as a transportation fuel.
6. Burning me can produce air pollution.

Geothermal

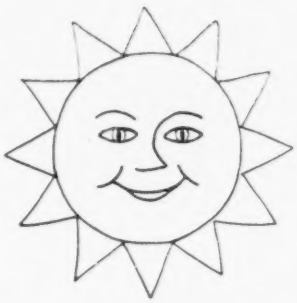
1. I'm 0.1 % of U.S. energy production.
2. I'm chiefly used in western states.
3. I can be used for home heating.
4. My energy comes from beneath the earth's surface.
5. My major job is production of electricity.
6. I get my energy as a result of radioactive decay.

Wind

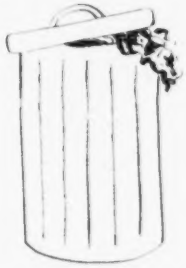
1. My effectiveness is limited to certain areas of the U.S.
2. I convert my mechanical energy directly into electrical energy with no cost for the fuel.
3. I produce noise pollution.
4. I was a big hit in Holland in the 17th century.
5. I'm less than 0.1% of U.S. electricity production.
6. I can also be used to pump water.

Solar

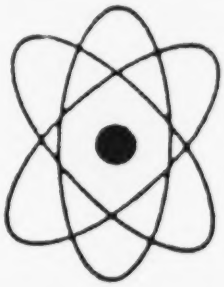
1. I'm 0.1% of U.S. energy production.
2. I can be converted directly into electricity using photovoltaic cells.
3. I'm great for hot water and home heating.
4. I work better in certain parts of the country than others.
5. I've been stored for millions of years in fossil fuels.
6. I'm free, but you have to purchase and maintain my equipment.



SOLAR



BIOMASS



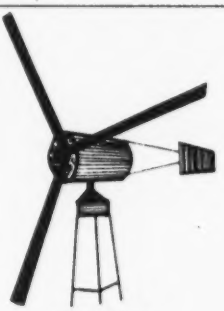
URANIUM

PETROLEUM

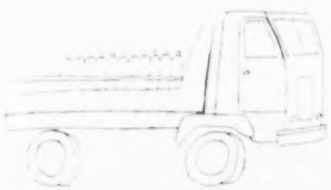
GEOTHERMAL

NATURAL GAS

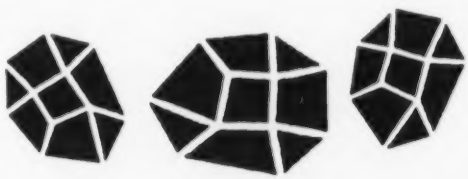
HYDROELECTRIC



WIND



PROPANE



COAL

HOT WATER HEATING
ENERGY NEWS TEAM INTRODUCTION

Now for tonight's micro-cam report. We have once again miniaturized a member of our Energy News Team staff to give you an inside look at what actually goes on inside your hot water heater. Heating hot water is the second largest energy consuming job in the home, using about 20 percent of total household energy. So, it's important to know what these drops of water are thinking while they're still inside the tank. We find their biggest fear is that their lives may be wasted by carelessness. Here's _____, who always seems to be getting into hot water, with this indepth report.

* Wash clothes in warm water and rinse in cold.
* Use low-flow shower heads.
* Do not let hot water run needlessly.
* Lower the water heater's thermostat to 120 degrees.
* Repair leaky faucets promptly.
* Use cold instead of hot water when running the garbage disposal, and when rinsing dishes before they go in the dishwasher.
* Insulate hot water tanks and piping.

HOME HEATING
ENERGY NEWS TEAM INTRODUCTION

The theft of home heating energy is a normal occurrence. So why the next story? Because our undercover reporter has been able to infiltrate a gang of home heating energy criminals. For the first time ever, we can bring you the story from the point of view of the criminals. Seeing how they operate might help you, our Energy News Team viewer, prevent them from stealing your energy dollars.

* Plant trees to act as a windbreak.
* Close off unoccupied rooms, and shut off their heating vents.
* Keep heating equipment well maintained.
* Keep draperies and shades open in sunny windows, and closed at night.
* During the winter, lower the thermostat to 65 degrees during the day, and 60 degrees at night.
* Keep doors and windows shut.
* Add insulation in the attic and walls where needed.
* Caulk and weather strip doors, windows and other areas in the home where drafts may occur.

AUTO DRIVING HABITS
ENERGY NEWS TEAM INTRODUCTION

Our next story may have some of you saying that group therapy sessions have gone too far. This time it's automobiles. Their operators have very bad driving habits, and these habits are driving the cars crazy. We visited one of these sessions to learn what can be done to reduce this conflict between cars and their drivers.

* Do not exceed the speed limit.
* Use public transportation.
* Do not overfill the gas tank.
* Eliminate jackrabbit starts and stops.
* Eliminate unnecessary trips, and plan trips carefully.
* Be a car pooler, and share a ride.
* Do not let an automobile idle for more than one minute when waiting for someone.

AUTO MAINTENANCE
ENERGY NEWS TEAM INTRODUCTION

I've just been handed a bulletin. American automobiles have just called a wildcat strike. They refuse to operate again until their list of demands is met. Their major concern is health care. They feel that their owners are not giving them the maintenance they deserve. An Energy News Team mobile unit brings us this late breaking story from a new car showroom, where new cars are refusing to leave the car lot with their owners. That's right folks, these autos are demonstrators.

* Check tire pressure every two weeks.
* Select the correct gasoline octane and grade of oil for the car.
* Remove unnecessary weight from the car.
* Keep the oil and air filters clean.
* Have the car's engine tuned regularly.
* Replace conventional tires with radials.
* Make sure breaks are operating properly.

LIGHTING ENERGY
NEWS TEAM INTRODUCTION

And now for the segment of the show that enables you, the viewer, to help put a dangerous energy criminal behind bars. It's time for America's Most Wanted Energy Criminals. The FBI has just put Killer Kilowatthour on its most wanted list. He has been terrorizing homes throughout the nation by forcing families to waste energy in lighting their home. Recently, he forced a family to leave ten 100 watt light bulbs on for an hour. If you recognize him from this next segment, please don't try to apprehend him yourself, just call our toll-free number, 1-800-TURNOFF. Remember, he's very dangerous because he's very bright.

* Use outdoor lights only when needed.
* Use fluorescent lights whenever possible.
* Keep all lamps and light fixtures clean, because dirt absorbs light.
* Turn down three-way light bulbs to the lowest setting when watching television.
* Reduce light in non-working areas.
* Use one large bulb, instead of several small ones, in areas where bright lights are needed.
* Turn off lights when leaving a room.

Energy Bingo

Instructions: Find 16 people who can answer questions A through P and write their names in the corresponding boxes below.

A. knows the cost of a kilowatt-hour

B. can name a fossil fuel

C. knows what energy source C_3H_8 is

D. can name two renewable energy sources

E. has visited a power plant

F. can name two ways to save energy at home

G. uses a hand-operated can opener

H. has never seen coal

I. recycles aluminum cans

J. has taken a cold shower

K. has seen a photovoltaic cell

L. knows the chemical name for natural gas

M. knows one way to use solar energy at home

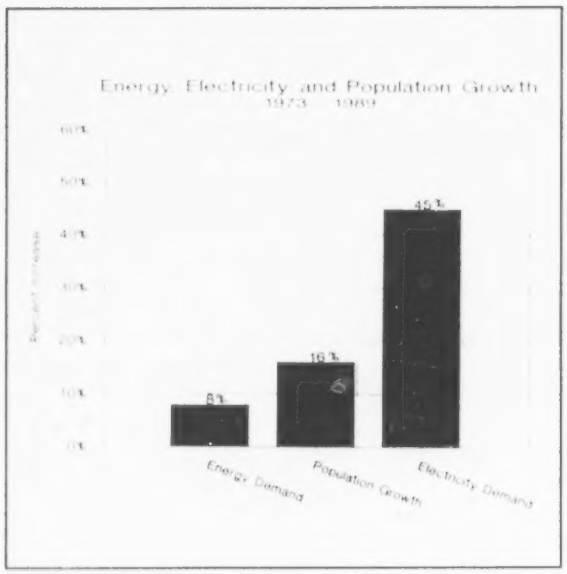
N. uses a solar clothes dryer

O. knows what gasahol is made of

P. knows which uranium isotope is fissionable

A _____ name _____	B _____ name _____	C _____ name _____	D _____ name _____
E _____ name _____	F _____ name _____	G _____ name _____	H _____ name _____
I _____ name _____	J _____ name _____	K _____ name _____	L _____ name _____
M _____ name _____	N _____ name _____	O _____ name _____	P _____ name _____

ELECTRIC CONNECTIONS
Game Instructions



In 1989, thirty-seven percent of all the nation's energy was used to make electricity. Experts predict that the figure will be forty percent by the year 2000. The United States is becoming more dependant on electricity to meet its energy needs. In the past 16 years the U.S. demand for electricity has grown by 45 percent, even though the population has only grown 16 percent and our energy demand by eight percent. To meet this demand a variety of energy sources are utilized. Some energy sources contribute a substantial amount to the need for electricity, while others contribute less than one-half a percent.

Individual Instructions

Your task is to rank the 10 sources of energy in order of their contribution to the U.S. electricity demand. Place a number one by the source that provides the largest amount of electricty, a number two by the source that provides the second largest, down to a number ten by the one that provides the least amount of electricty. As you are doing this, try to think of good reasons for your ordering.

Group Instructions

Starting at the top of the list, ask members to contribute any knowledge they have about each energy source. Brainstorm by asking group members questions such as:

- Is this source limited to a certain area of the country?
- Are their any problems or limitations associated with this source?
- Have you ever seen a power plant that uses this particular source of energy?

One person in the group should take notes. Once the group has gone through the list, they should divide the ten energy sources into three levels of importance: the top three most significant energy sources, the middle four moderately significant energy sources, and the bottom three least significant energy sources. The group should then rank the 10 sources of energy in order of their contribution to the U.S. electricity demand.

Here are the 10 sources used to generate electricity:

Source	Your Rank	Group Rank
Biomass		
Coal		
Geothermal		
Hydropower		
Natural Gas		
Uranium		
Petroleum		
Propane		
Solar		
Wind		

U.S. Electric Power Generation Sources

Name	1989 Statistics	Ranks	Your Ranks	Error Points	Group Ranks	Error Points
Biomass	Biomass produced 1,965 million killowatt-hours of electricity. This represents less than 0.1 percent of the nation's electricity. Biomass energy is the result of burning wood and solid waste.	6				
Coal	Eighty percent of the nation's coal is consumed by electric utility companies to produce electricity. Coal produced 1,551,852 million killowatt-hours of electricity, which is fifty-seven percent of the nation's electricity.	1				
Geothermal	Geothermal energy produced 9,342 million killowatt-hours of electricity, chiefly from geothermal facilities in the western United States. Geothermal energy produced 0.33 percent of the nation's electricity.	7				
Hydropower	Almost ten percent of the nation's electricity was generated by 2,000 dams nationwide. Hydropower produced 265,061 million killowatt-hours of electricity. It is the leading renewable source used to provide electricity.	4				
Natural Gas	Natural gas produced 264,957 millon killowatt-hours of electricity, generating ten percent of the nation's electricity. Approximately one-half of this natural gas was used by gas turbines to provide electricity during peak hours of demand.	3				
Uranium	One hundred and nine nuclear power stations provide the nation with almost twenty percent of its electrical energy needs. Uranium produced 529,355 million killowatt-hours of electricity.	2				
Petroleum	Petroleum provided six percent of the nation's electricity last year through 158,241 million killowatt-hours of electric power generation.	5				
Propane	There are no statistics available for propane's contribution to electrical production. Very litttle propane, if any, is used to produce electricity.	10				
Solar	Solar provided less than 0.0001 percent of the nation's electricity last year through 2.6 million killowatt-hours of electricity. Most solar generated electricity comes from thermal solar sources, and a small amount from photovoltaics.	9				
Wind	Wind energy produced 0.5 million killowatt-hours of electricity. Wind energy provides less than 0.0001 percent of the nation's electricity. Ninety-five percent of the nation's wind generated electricity is produced in California.	8				

TOTAL _____ _____

Error points are the absolute difference between your ranks and EIA's (Disregard plus or minus signs).

Source: Energy Information Administration

Scoring for individuals:

0-12 – excellent
13-18 – good
19-24 – average
25-30 – fair
31-36 – poor
37-42 – very poor